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A MANUAL

OF

MATERIA MEDICA AND THERAPEUTICS

ROYAL·COLLEGE·OF·SURGEONS·OF·ENGLAND·

ROYLE'S

MANUAL OF MATERIA MEDICA
AND THERAPEUTICS

INCLUDING THE PREPARATIONS OF THE

BRITISH PHARMACOPŒIA

AND OTHER APPROVED MEDICINES

Royle

Sixth Edition

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ON PHYSIOLOGY AT, ST THOMAS'S HOSPITAL

ROYAL COLLEGE OF SURGEONS OF ENGLAND
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PREFACE TO THE SIXTH EDITION.

The recent death of Dr Headland has deprived the Publishers of the aid which he had so long and efficiently given to this work, and no more fitting opportunity than this could be afforded of acknowledging his labours and talents. Dr Headland assisted Dr Royle in the preparation of the Second and Third Editions, and after the death of the author he was solely responsible for those subsequently published. As a pioneer in the study of Therapeutics, Dr Headland's name has been long and favourably known, and his untimely removal from amongst us will be regarded with deep regret by those who have been looking for the fruits of his more matured experience.

Nearly eight years have elapsed since the appearance of the last Edition of this Manual,—a period of unprecedented activity in all matters connected with Materia Medica and Therapeutics, and one which is generally acknowledged to have been marked by a real advance of knowledge. This circumstance, together with the change of chemical nomenclature, and the acknowledged need of a more careful study of Therapeutics, have rendered a thorough revision of the work necessary. The present edition, indeed, has been almost entirely rewritten. The preparations of the British Pharmacopœia are fully described, and, as occasion requires, freely criticised. The American, French, and German Pharmacopœias have been consulted, and from these, and other sources, all materials and compounds of accredited utility and advantage have been introduced and examined. The text is further illustrated by 26 new figures.

A large space, occupied in previous Editions by details which are to be found in elementary works on Botany, has been appropriated to an account of the actions of medicines, and in effecting this the Editor has embodied the results of his own observations. Those who look for the results of experiments on mutilated animals, in the following pages, will not find them, for the Editor is satisfied that this is not legitimate Therapeutical inquiry, and that nothing short of a patient survey of the operation of a drug in the entire body in health, and under the variable influence of disease, can furnish the data upon which we may build a proper theory of its action.

Those whose attainments do not extend to natural science, and who look for a cut-and-dried system of Therapeutics, will perhaps find in the few pages devoted to the classification of remedies sufficient to satisfy their wants; but it is hoped that the majority of those who use the work will be ready to acquiesce in an arrangement which has the advantages of natural association, and the sanction of custom.

78 Upper Berkeley Street,
Portman Square. W.,
December 1875.

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ERRATA.

Page 79, 2 lines from bottom, *for* Iodidi, *read* Iodidum.
Page 100, 4 ,, ,, bottom, *for* protosalts, *read* persalts.
Page 124, 4 ,, ,, top, *for* KO_2, *read* K_2O.
Page 148, 19 ,, ,, top, *for* NaO_2, *read* Na_2O.
Page 163, 17 ,, ,, bottom, *for* Phosphitis, *read* Phosphis.
Page 418, 20 ,, ,, top, *for* Gall, *read* Galla.
Page 455, 10 ,, ,, bottom, *for* Cinnamonmum, *read* Cinnamomum.
Page 461, 21 ,, ,, top, *for* Beebeeru, *read* Bebeeru.
Page 461, 29 *et seq.* ,, top, *for* Berberia, *read* Beberia..
Page 558, 6 lines ,, top, *for* Cinchonida, *read* Cinchonidia.

MATERIA MEDICA AND THERAPEUTICS.

INTRODUCTION.

A COMPETENT, not to say an accomplished, medical practitioner, must be able to recognise the appearances and indications of accident, the variations and deviations of function which constitute disease; and having recognised them, must be familiar with the means of curing or alleviating them. Anatomy and Physiology guide him to the former, and Surgery and Therapeutics furnish him with the latter. This knowledge when reduced to practice, consists merely in the application of remedies for the relief of suffering and the removal of disease, and naturally resolves itself into Medicine and Surgery. But while comparatively few of us require the aid of the surgeon, most of us will, sooner or later, be prostrated by disease. Therefore, of all branches of medical knowledge, that which relates to the action and use of medicines is the most essential, because it admits of by far the widest application. Even the surgeon is poorly equipped if his knowledge be confined to bare manipulation. A bold and skilful operator, he may remove the disease effectually, and with the least amount of risk to the patient; but if he be ignorant of the means of staying its origin and progress, or of relieving attendant disturbances of the system, he will often be baffled, and not unseldom defeated in his endeavours to cure the patient. But the *medical* practitioner is a mere pretender if he lack this necessary knowledge; for he is not only powerless to do good, but is very apt and sure to do harm, both by omission and commission. Those who guide the medical education of this country are much to blame for the very inadequate provision made for the education of the medical student in the use of drugs. As a consequence, numbers of young men, unfortunately for medicine and their own professional welfare, come fresh from school or college to enter upon their four years' course of medical study, and never form a just estimate of their responsibility to the public in the use of remedies. Many, indeed, are inclined to regard rhubarb, julap, and the like, as unworthy the attention of one who knows something of Greek hexameters and the differential calculus, and that such gross and commonplace things are best left to the care and consideration of the pharmacist. If any of my readers should be inclined to this view, I would remind them that gentle manners and persuasive speech, proper and desirable though they be, will neither free an obstruction nor bind a diarrhœa; and that if they do not know what to prescribe and how to proportion the dose to the relief of the patient, they will sooner or later be confronted by their ignorance, and humbled by the reflection that the only weapons which can help them to make a worthy stand against the general foe are useless to them. Nothing secures the confidence of the patient more readily and completely than the ability to predicate the effect of the medicine which you prescribe for him. He himself expects results, and if these accord with your predictions, you have already done much to relieve him. To be able to do this, implies a knowledge of most that is written in the following pages, and besides this, a great deal more that cannot be written. No one ever became an exact fencer by bare study of the written descriptions of the poses, passes, feints, and foils of the art, nor an accomplished musician by the theoretical study of harmonics. For the same and even a stronger reason, no one can become even moderately competent to employ medicines for the relief of disease, unless he have diligently watched their operation at the bedside. A faithful study of the following pages, aided and supplemented by the prescribed courses of lectures and practical Pharmacy, will provide a foundation for therapeutical knowledge; but the superstructure itself must be built up of observations personally made and recorded, and repeated under a great variety of conditions.

The Materia Medica is a choice repertory of the most precious gifts of nature and of science, and, as such, its individual objects are intrinsically interesting. The three kingdoms of nature are fully represented. Chemistry is the presiding genius, and is attended by Mineralogy, Botany, and Zoology, and we are incidentally introduced to some of the most interesting operations of animals and plants.

But it is necessary to know these objects, not only for their own sake, but to detect the impurities which they acquire by association, and the adulterations which are imposed by dishonesty. In the present day it would be folly to shut one's eyes to the fact, that we may have been watching day after day, and week after week, for the effects of a given medicine which we have prescribed, and at a loss to account for their absence, and at the end of this time discover, if we have the ability to do so, that the active principle is wanting. Severe competition between wholesale druggists, and the absence of an authorised and unexpected inspection of the drugs kept by both wholesale and retail druggists, render the precautions given under *characters and tests* in the Pharmacopœia absolutely necessary; and if a medical practitioner should be incapable of ascertaining the purity of the drugs he prescribes, he will, unless he send his patient to a reliable source, soon begin to lose faith in his prescriptions.

A good practical knowledge of Chemistry is, therefore, necessary to the preliminary study of Materia Medica, and, following the example of the distinguished author and previous learned editor, it has been my endeavour to give Chemistry full scope and illustration in this work. In a word, to make it complete and independent in this respect. And I have been led to do so by the consideration that a knowledge of Chemistry is indispensable to the study of Therapeutics. In order to employ drugs with certainty for the relief of suffering or the cure of disease, we must seek to know what part they will take in the chemical and physical processes upon which life depends; for this really constitutes the science of therapeutics (θεραπεύω, to heal).

THERAPEUTICS.—The body is a slow-burning furnace, where a number of chemical or electrolytic operations are going on simultaneously, each one apparently for a separate purpose, but actually related to and working with all the rest for one grand result,—the renewal of the blood, and the maintenance of its healthy condition; the vital fluid itself exciting the various operations, and, in its busy and incessant round, at once connecting them in one complex circuit, and co-ordinating them in reciprocal action.

We cast our drugs into this living crucible—the blood—and we seek to know what becomes of them: how, when, and where they pass out of it; what influence they exert upon the blood itself, and upon the various operations of the body in their transit; and, thirdly, *how* they act. Nor is this all; after we have assured ourselves of the behaviour of a medicine on the healthy body, we must ascertain whether this is modified in various morbid states of the system. The study of Therapeutics is, therefore, a very complex one, and resolves itself into a consideration of—1. The changes undergone by the drug itself; 2. Its effects on the body generally, and on certain parts in particular; 3. The mode of its action; and, lastly, 4. The difference, if any, in its action on the healthy and diseased condition of the body. Each of these topics requires a little illustration.

1. *As to the Changes undergone by the Drug itself.*—(*a.*) It may disappear totally. This is the case with conia, camphor, turpentine, and many others.

(*b.*) It may be passed out of the body, unchanged and undiminished, as occurs with atropia and its allies, iodide of potassium, and the neutral salts generally.

(*c.*) Or it may be decomposed, and recognisable in another form. Thus, benzoic acid is converted into hippuric acid; and the salts formed by the combination of the alkalies and vegetable acids are reduced to carbonates.

The form in which a decomposed salt is eliminated is a point of much interest and importance, as throwing light at once upon the operation of the bodily functions and upon the influence of the drug itself. Generally speaking, the changes observed in the drug are those due to oxydation.

2. *As to the Effects of the Action of Medicines.*—These are various.

Thus opium, alcohol, and the general anæsthetics, act on the cerebro-spinal nervous system, producing more or less complete paralysis of this part of the body, as indicated by complete flaccidity of the muscular system, and a state of unconsciousness. Hemlock leaves the intelligence and sensory system intact, while it paralyses the motor system. Strychnia causes spasms of the voluntary muscles, and ergot contractions of the involuntary. Atropia stimulates the sympathetic nervous system. Hydrocyanic acid rapidly abolishes all the functions.

3. *As to the Mode of Action.*—How does opium produce sleep, strychnia tetanus, and prussic acid its swiftly fatal effects? What a commotion the $\frac{1}{60}$ of a grain of atropia produces in the body, until the last trace is eliminated, and every atom passes out unchanged! How does it bring about the great cardiac excitement, the parched tongue, and the dilated pupil? We can only answer, "by a stimulant action on the sympathetic nervous system, and a closure of certain blood-vessels." But such an answer brings us only a step nearer to the cause; for, granting that all the effects observed result from stimulation of the sympathetic, we have still to learn how atropia stimulates the sympathetic. Such questions are the most recondite that can be submitted to observation and reflection; for on their solution hinges that of the highest problem of all,—the origin and nature of life. Truly, the most complex phenomena which science presents to the chemist or the astronomer, are simplicity itself when compared with the higher problems of therapeutical inquiry. The difficulties which beset the subject have always been a great discouragement to those who have been most fitted to grapple with them, while they have engendered indifference in the general mass of medical men. Still, the facts which patient observation is accumulating are sufficiently numerous and to the point, to give encouragement to all, and to prepare the way for simple intelligible theories. Many suggestions of this kind will be found in the following pages; for I have felt that if I may take my own wants as representing in any degree those of my readers, much good may be done by fixing the attention on reasonable explanations when we cannot direct it to positive facts. In considering the mode of action of a drug, we have first to ascertain how it obtains entrance into the blood (*absorption*) and exit from it (*elimination*). In a word, we have to consider it in reference to osmose, or to the passage of fluids through membranes. As a rapidly flowing liquid, and on account of its high specific gravity (1050), which is greater than that of any of the fluids of the body, and of its alkalinity, the blood is in a perfect condition for promoting the ingress of soluble matters of all kinds into the blood-vessels; while it is prevented, by its colloidal qualities, from passing out of its containing vessels; and this accounts for the rapid absorption of fluids into the blood. But in the case of a large number of chemical salts,—such, for example, as chloride of calcium (which see), this must not be regarded as a mere mechanical process. In the elucidation of this subject the following

facts, due to Graham (*Phil. Trans.*, 1854), must be kept in view:—1. Colloids (uncrystallisable substances, as gum, albumin, gelatin), and neutral organic substances (such as wax, sugar of milk, salicin), have little or no capacity for passing through animal membranes, or osmotic action. 2. Neutral salts (such as common salt and sulphate of magnesia) readily pass through the membrane either way, and indeed diffuse into the liquid in their vicinity at the same rate as when no membrane intervenes. 3. Alkaline solutions, and especially those of carbonates of potash and soda, produce *endosmose* to a great extent; and the influx is greatest when the quantity of the alkaline salt does not exceed 2 per cent. 4. Acids, and solutions of acid salts, commonly induce a flow of fluid out of the osmometer, or excite *exosmose.* 5. A solution composed of two salts often has a different osmotic power from that of a solution of each separately, *e.g.*, the osmotic action of neutral sulphate of potash or soda is increased five times by the addition of 1 part of carbonate of potash to 10·000 of the solution. The addition of an equally minute trace of hydrochloric acid stops the action almost completely. Chloride of sodium is remarkable for reducing osmotic action in other salts. 6. Whenever osmotic action takes place (excepting with alcohol and cane sugar), a chemical action on the membrane occurs simultaneously, and osmose is most effectually induced when this chemical action on the septum is secured by bringing fluids of opposite character (such as acid and alkali) in contact with its surfaces.

It appears, therefore, that the ultimate acts of absorption and elimination are something more than mere filtration, and that medicines may produce an immediate effect on the body by inducing a chemical change in the membranes through which they pass in their way into or out of the blood.

Their action upon the blood itself is another question of the highest importance, and the effects of a large number of drugs are probably due to this cause simply. Aliments which furnish the blood with albumin and fat are properly regarded as *restoratives*, since these are being constantly abstracted from it; in like manner, any medicine which facilitates the absorption of the nutritive pabulum, or supplies a deficiency of its mineral constituents, is a restorative. *Antiphlogistic* remedies are assumed to prevent the coagulation of the fibrin, and the adhesive aggregation of the red corpuscles, by a mere solvent action. *Acids* remove excess of alkali, and *antacids* excess of acid, by direct chemical neutralisation. Thus far the action of medicines on the blood is clear and intelligible, and we have seen that the action of the blood on certain drugs, susceptible of further oxidation, is equally intelligible; and the reverse of these propositions is true. Thus, for example, antiphlogistics, if used unnecessarily or too long, produce an impoverished condition of the blood; and acids, given in an abnormally acid state of the system, increases the acidity of the blood. If we go much further than this we get on debatable ground; thus mercury is *antisyphilitic*, by destroying the syphilitic poison. Let it be granted that syphylis is a fungus, and then we know how mercury acts—it simply kills the vegetable. Again, prussic acid kills by paralysing the red blood corpuscle; it will no longer take carbonic acid from the tissues, nor give them oxygen. These are simple propositions; but how difficult of proof!

But it is on the nervous system that the effects of medicines are most conspicuously displayed, while their modes of action are altogether obscure. We must look upon the nervous system collectively as a compound voltaic battery, and the nerve force as electricity. We may indeed safely assume so much. Reduced to this simple view, we may suppose that neurotic medicines act by exciting or depressing the chemical reactions on which the development of nerve force depends, and, by increasing or diminishing the conducting power of the nerve fibres, may cause spasm or palsy accordingly. The electrolytic actions, which generate nerve force, are probably induced by the decomposition of complex organic substances, as albumin; and it is possible that the presence of such similarly constituted bodies as strychnia, quinia, morphia, and the like,—all of which significantly contain nitrogen,—in the central nervous system, may have a similar effect upon the changes going on in the nerve cells, as the addition of sulphuric acid or neutral oxalate of potash to a cell of Daniell's battery would have on the current proceeding from it.

To sum up, the fundamental action of drugs is fourfold—first, they may retard or accelerate osmose; secondly, they may alter the condition of the blood; thirdly, they may increase or diminish those changes in the nerve cells which result in the generation of nerve force; and lastly, by virtue of similar influences they may increase or diminish the conductivity of the nerve fibres.

We have still to consider the fourth topic.

4. *The Influence of Disease in modifying the Action of Medicines.*—This is a subject which, when fully known, will fill volumes. Our present knowledge of it is limited to a few lines, and may be represented in the following propositions and facts:—

(*a.*) A hindrance to absorption renders the action of medicines slow and uncertain. This is illustrated by the difficulty with which the effects of mercury are induced in congested or inflammatory conditions of the alimentary canal, such as commonly accompany the febrile state.

(*b.*) A hindrance to excretion, on the other hand, prolongs and intensifies the action. Thus morphia and atropia are both eliminated by the kidneys; and in a congested condition of this organ, as in acute nephritis or uræmia, these drugs are retained in the blood, and an ordinary medicinal dose will sometimes in these conditions produce toxic symptoms.

(*c.*) The reverse of these two propositions is true; and when the excretions are unusually free, the effects of a given dose are less apparent. Thus, in diabetes, both opium and belladonna are tolerated in a remarkable way.

(*d.*) A diseased condition of a particular organ may have the effect of altogether preventing those changes in the drug which are observed in the healthy condition. Thus in certain morbid conditions of the liver, Kühne found that benzoic acid did not undergo its usual transformation into hippuric acid.

Observations such as this last cast a hopeful ray of light on the study of Therapeutics, which is as yet in its infancy. When we know completely the action of medicines on the system, we shall be able to apply them as measures of healthy function (see conium), and to use them, both as physiological tests of the presence and locality of disease, and at the same time, as intelligible remedies for its relief. The mind cannot find nobler occupation than this, for it combines the highest science with the most practical expression of good-will to man and the domestic animals.

THE PHARMACOPŒIA.

A Pharmacopœia (φάρμακον, a medicine, ποιέω, to make), is an authority for the use of such drugs as experience has proved to possess remedial or alleviating effects on disease and its attendant symptoms; and such an authority is needed not only for securing general uniformity and purity in the drugs, but also for prescribing convenient forms of administering them.

The British Pharmacopœia of 1864, issued by the General Council of Medical Education and Registration, in accordance with the Medical Act of 1858, superseded the Pharmacopœias of London, Edinburgh, and Dublin, and established the long-desired uniformity in the preparation of medicines and the compounding of prescriptions throughout the United Kingdom. The reprint, with additions, of 1874 is, for the present, the sole authority recognised by law for the guidance of medical practitioners and druggists throughout the United Kingdom.

Chemical Notation.

A few words of explanation are desirable in this place to reconcile the old and new views of the composition of salts as expressed by chemical notation, and to explain some of the principles involved in the latter. According to the old theory, acids were of two kinds, the *hydracids* and the *oxyacids*—*e.g.*, HCl and HO,SO_3. When these were brought in contact with a metallic oxyde, a *haloid salt* was formed in the case of the former, and an *oxy salt* in the case of the latter, thus—

$$\begin{aligned} CuO + HCl &= CuCl + HO \\ CuO + HO,SO_3 &= CuO,SO_3 + HO. \end{aligned}$$

It is apparent from the first formula that both oxyde of copper and hydrochloric acid have been decomposed; whereas it appears from the second that the oxyde of copper merely displaces the water of the sulphuric acid—in the one case there is double decomposition, and in the other a simple union of the base and acid with displacement of water.

Now, the new theory is intended to reconcile this difference, and to assimilate all chemical actions to the first of the two types given above; and for this purpose it assumes that sulphuric acid is not

HO,SO_3, that is, anhydrous sulphuric acid united with an equivalent of water, but HSO_4, the SO_4 being a compound (called *sulphion*) of the anhydrous acid with an equivalent of oxygen, and which is to the hydrogen of hydrated sulphuric acid what chlorine is to the hydrogen of hydrochloric acid—the hydrogen, in fact, forming a weak base to both the chlorine and sulphion, and as such being easily displaced by a stronger, a metal for example, thus—

$$\begin{aligned} HCl + Zn &= ZnCl + H \\ HSO_4 + Zn &= ZnSO_4 + H. \end{aligned}$$

and in contact with a metallic oxyde—

$$\begin{aligned} HCl + CuO &= CuCl + HO \\ HSO_4 + CuO &= CuSO_4 + HO. \end{aligned}$$

As ZnCl and CuCl consist of single atoms of two elements only, they are strictly and simply binary compounds, and if the binary theory be applied to the oxy salts, we must assume that the grouping of their molecules corresponds to that of the simpler binary compounds above symbolised, and that all salts consist of two portions, one, the *radicle*, consisting of either a non-metallic element, *e.g.*, chlorine, or of an equivalent compound body, *e.g.*, SO_4 (which may be distinguished as the *oxion*): and the other the *base*, which is either a metal or a compound, like ammonium. Much may be said in favour of both views, but there remains a balance for the binary theory, and it has therefore been adopted in this work, but not to the exclusion of the other; and as Roman and Egyptian type distinguish the formulas representing the two theories, there is no danger of confusion.

A little explanation is also necessary in order to understanding clearly the principles of the binary theory. 1. The smallest quantity of an element capable of uniting with any other is called an *atom;* and this chemical atom is always expressed by the symbol of the element. 2. The term *molecule* implies the smallest quantity of an element or compound capable of existing in a free state; and it usually consists of two atoms. Thus, for example, hydrogen, oxygen, and sulphur are respectively represented by $H_2 = 2$, $O_2 = 32$, and $S_2 = 64$. The smallest quantities of compounds, whether free or combined, are also called molecules, excepting when, as happens with a part of them, they combine with other bodies in still smaller quantities. In this case the smaller quantity is called an atom. Thus ethyl in combination is represented by C_2H_5, and in its free state by C_4H_{10}, the former being its atom and the latter its molecule. 3. The terms *chemical equivalent*, *equivalent weight*, and *atomic weight* are no longer synonymous. The numbers given in the table, p. 10, represent the atomic weights of the elements there symbolised, and it will be observed that those of three non-metallic and fifteen metallic are doubled by adopting the new theory. The atomic weight of $H = 1$, and that of $O = 16$, but when they combine two parts of hydrogen unite with 16 of oxygen, and we are therefore obliged to say that O_{16} is *equivalent* to H_2.

The accompanying table contains the names, symbols, and atomic weights of the thirty-three elements employed directly or indirectly in the Pharmacopœia.

Elements.	Symbols and Atomic Weights.	
	Old Theory.	New Theory.
1. Aluminium,	Al = 13·75	**Al** = 27·5
2. Antimony (Stibium),	Sb = 122	**Sb** = 122
3. Arsenic,	As = 75	**As** = 75
4. Barium,	Ba = 68·5	**Ba** = 137
5. Bismuth,	Bi = 210	**Bi** = 210
6. Boron,	B = 11	**B** = 11
7. Bromine,	Br = 80	**Br** = 80
8. Cadmium,	Cd = 56	**Cd** = 112
9. Calcium,	Ca = 20	**Ca** = 40
10. Carbon,	C = 6	**C** = 12
11. Cerium,	Ce = 46	**Ce** = 92
12. Chlorine,	Cl = 35·5	**Cl** = 35·5
13. Chromium,	Cr = 26·25	**Cr** = 52·5
14. Copper (Cuprum),	Cu = 31·75	**Cu** = 63·5
15. Gold (Aurum),	Au = 196·5	**Au** = 196·5
16. Hydrogen,	H = 1	**H** = 1
17. Iodine,	I = 127	**I** = 127
18. Iron (Ferrum),	Fe = 28	**Fe** = 56
19. Lead (Plumbum),	Pb = 103·5	**Pb** = 207
20. Lithium,	L = 7	**L** = 7
21. Magnesium,	Mg = 12	**Mg** = 24
22. Manganese,	Mn = 27·5	**Mn** = 55
23. Mercury (Hydrargyrum),	Hg = 100	**Hg** = 200
24. Nitrogen,	N = 14	**N** = 14
25. Oxygen,	O = 8	**O** = 16
26. Phosphorus,	P = 31	**P** = 31
27. Platinum,	Pt = 98·5	**Pt** = 197
28. Potassium (Kalium),	K = 39	**K** = 39
29. Silver (Argentum),	Ag = 108	**Ag** = 108
30. Sodium (Natrium),	Na = 23	**Na** = 23
31. Sulphur,	S = 16	**S** = 32
32. Tin (Stannum),	Sn = 59	**Sn** = 118
33. Zinc,	Zn = 32·5	**Zn** = 65

To avoid confusion entailed by the general acceptance of the binary theory of the composition of salts, the Pharmacopœia Committee has wisely given both the old and new notation, to indicate the composition of the chemical compounds treated of, and distinguished them by the use of different types, those representing the old system being printed in the lighter Roman type (Al), and those representing the new in the heavier Egyptian character (**Al**). This rule has been followed in the present work, while at the same time the new system is freely used and abundantly illustrated.

WEIGHTS AND MEASURES.

The initial weight, or grain, is the same in both troy and avoirdupois. It must be remembered that troy weight is no longer used in the Pharmacopœia, though the drachm (ʒj = 60 grains) and scruple (℈i. = 20 grains) are frequently resorted to by prescribers.

WEIGHTS.

1 Grain, gr.
1 Ounce, oz. = 437·5 grains.
1 Pound, ℔. = 16 ounces = 7000 „

MEASURES OF CAPACITY.

1 Minim,	Min.,	or ♏	
1 Fluid drachm,	fl. drm.,	or fʒ	= 60 minims.
1 Fluid ounce,	fl. oz.,	or f℥	= 8 fluid drachms.
1 Pint,	O,		= 20 fluid ounces.
1 Gallon,	C,		= 8 pints.

MEASURES OF LENGTH.

1 Line = $\frac{1}{12}$ inch.
1 Inch = $\frac{1}{39\cdot1393}$ seconds pendulum.
12 Inches = 1 foot.
36 Inches = 3 feet = 1 yard.

Length of pendulum vibrating seconds of mean time in the latitude of London, in a vacuum at the level of the sea, 39·1393 inches.

RELATION OF MEASURES TO WEIGHTS.

1 Minim	is the measure of			0·91	grs. of water.
1 Fluid drachm	„	„		54·68	„
1 Flud ounce	„	„	1 ounce, or	437·5	„
1 Pint	„	„	1¼ pound, or	8,750	„
1 Gallon	„	„	10 pounds, or	70,000	„

WEIGHTS AND MEASURES OF THE METRICAL SYSTEM.

WEIGHTS.

1 Milligramme	= $\frac{1}{1000}$ part of a gramme, or	0·001	gramme.
1 Centigramme	= $\frac{1}{100}$ „ „	0·01	„
1 Decigramme	= $\frac{1}{10}$ „ „	0·10	„
1 Gramme	= weight of cubic centimetre of water at 4° C,	1·0	„
1 Decagramme	= ten grammes, or	10·0	grammes.
1 Hectogramme	= a hundred grammes, or	100·0	„
1 Kilogramme	= a thousand grammes, or	1000·0	„

MEASURES OF CAPACITY.

1 Millilitre	= 1	cubic centimetre, or the meas. of	1	grm. of water.
1 Centilitre	= 10	„ „ „	10	„
1 Decilitre	= 100	„ „ „	100	„
1 Litre	= 1000	„ „ „	1000	„

MEASURES OF LENGTH.

1 Millimetre = $\frac{1}{1000}$ part of one metre, or 0·001 Metre.
1 Centimetre = $\frac{1}{100}$ " " 0·01 "
1 Decimetre = $\frac{1}{10}$ " " 0·1 "
1 Metre = the ten-millionth part of a quarter of the meridian of the earth.

RELATION OF THE WEIGHTS OF THE BRITISH PHARMACOPŒIA TO THE METRICAL WEIGHTS.

1 Pound = 453·5925 grammes.
1 Ounce = 28·3495 "
1 Grain = 0·0648 "

RELATION OF MEASURES OF CAPACITY OF THE BRITISH PHARMACOPŒIA TO THE METRICAL MEASURES.

1 Gallon = 4·543487 litres.
1 Pint = 0·567936 " or 567·936 cubic centimetres.
1 Fluid ounce = 0·028396 " " 28·396 "
1 Fluid drachm = 0·003549 " " 3·549 "
1 Minim = 0·000059 " " 0·059 "

RELATION OF THE METRICAL WEIGHTS TO THE WEIGHTS OF THE BRITISH PHARMACOPŒIA.

1 Milligramme = 0·015432 grains.
1 Centigramme = 0·15432 "
1 Decigramme = 1·5432 "
1 Gramme = 15·432 "
1 Kilogramme = 2 lbs. 3 oz. 119·8 grs., or 15432·348 "

RELATIONS OF THE METRICAL MEASURES TO THE MEASURES OF THE BRITISH PHARMACOPŒIA.

1 Millimetre = 0·03937 inches.
1 Centimetre = 0·39371 "
1 Decimetre = 3·93708 "
1 Metre = 39·37079 " or 1 yard 3·7 inches.
1 Cubic centimetre = 15·432 grain measures.
1 Litre = 1 pint 15 oz. 2 drs. 11 m., or 15432·348 grain measures.

VOLUMETRIC ESTIMATIONS.

In order to ascertain the purity of certain preparations, the Pharmacopœia directs the use of standard "volumetric solutions," the preparation and use of which are in each case considered under the class to which it belongs.

According to the British system of weights and measures, the quantities of the substances to be tested are expressed in *grains*, by weight; and the quantities of the test solutions employed to ascertain their purity are expressed in *grain measures*—the grain measure being the volume of a grain of distilled water.

According to the metrical system, which is usually adopted by scientific chemists, grammes and cubic centimetres are used for the same purposes—the cubic centimetre being the volume of a gramme of distilled water.

As the cubic centimetre bears the same relation to the gramme that the grain measure does to the grain, the one system may be substituted for the other (the same volumetric solution being used) with the same results. For, in substituting grains and grain measures for grammes and cubic centimetres, we reduce to grains, then multiply by 10, and divide by 15·432 grains (=1 gramme, or 1 cubic centimetre); thus, to change 5 grammes into grains,

$$\frac{10\,(5 \text{ grammes} \times 15{\cdot}432)}{15{\cdot}432} = 50 \text{ grains.}$$

So also in substituting cubic centimetres (15·432 grain measures), for decems (10 grain measures).

And the reverse process for substituting grammes and cubic centimetres for grains and grain measures; thus,

$$\frac{15{\cdot}432\,(50 \text{ grains} \div 10)}{15{\cdot}432} = 5 \text{ grammes.}$$

Therefore, in testing with these standard solutions according to the metrical system, all that is needed is to remove the decimal point one place to the left; thus, 50·0 grains would be changed into 5·0 grammes, and 1000 grain measures into 100 cubic centimetres, and *vice versa;* 5·0 grammes would be changed to 50·0 grains, and 100 cubic centimetres into 1000 grain measures.—See Volumetric Solutions, Bichromate of Potash, and others.

The following apparatus is required in the preparation and use of these solutions.

For British weights and measures:—

1. A flask, fig. 1, which, when filled to a mark on the neck, contains exactly 10,000 grains of water at 60°. The capacity of the flask is therefore 10,000 grain measures.
2. A graduated cylindrical jar, fig. 2, which, when filled to O, holds 10,000 grains of water, and is divided into 100 equal parts.
3. A burette, fig. 3—a graduated glass tube, which, when filled to O, holds 1000 grains of water, and is divided into 100 equal parts. Each part, therefore, corresponds to 10 grain measures or a decem.

For metrical weights and measures:—

1. A glass flask, fig. 1, which, when filled to a mark on the neck, contains 1 litre, or 1000 cubic centimetres.*
2. A graduated cylindrical jar, fig. 2, which, when filled to O, contains 1 litre (1000 cubic centimetres), and is divided into 100 equal parts.
3. A burette, fig. 3—a graduated glass tube, which, when filled to O, holds 100 cubic centimetres, and is divided into 100 equal parts.

Volumetric solutions should be shaken before they are used, in order that they may be throughout of uniform strength. They should be preserved in stoppered bottles. All measurements should be made at 60° Fahr.

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* A cubic centimetre is the volume of a gramme of water at 4° C; but it is customary to make the measurements with metrical apparatus at 60° Fahr.

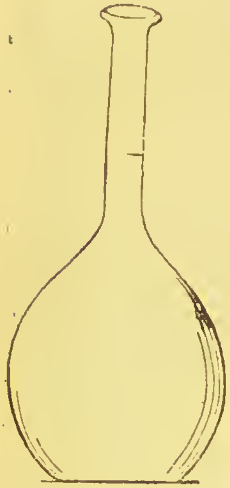


Fig. 1.

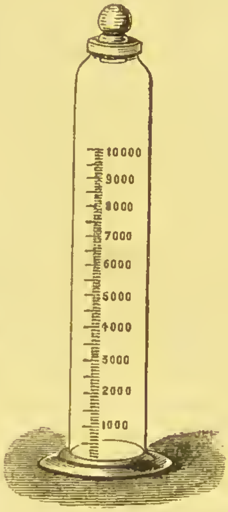


Fig. 2.

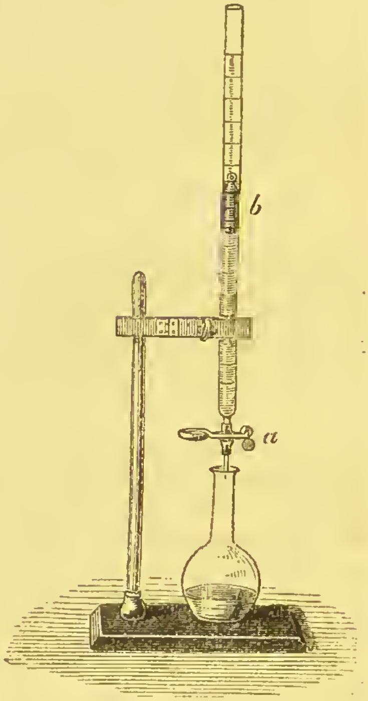


Fig. 3.

The following Articles are employed in Chemical Testing.

Volumetric solution of—
1. Bichromate of Potash.
2. Hyposulphite of Soda.
3. Iodine.
4. Nitrate of Silver.
5. Oxalic Acid.
6. Soda.

7. Absolute Alcohol.
8. Benzol.
9. Boracic Acid.
10. Chloride of Barium.
11. Copper Foil.
12. Fine Gold.
13. Hyposulphite of Soda.
14. Indigo.
15. Isinglass.
16. Litmus, Tincture, and Litmus Paper, red and blue.
17. Oxalic Acid.
18. Oxalate of Ammonia.
19. Plaster of Paris.
20. Platinum Black and Platinum Foil.
21. Red Prussiate of Potash.
22. Subacetate of Copper, commercial (Verdigris).
23. Sulphate of Copper (anhydrous).
24. Sulphide of Iron.
25. Sulphuretted Hydrogen.
26. Tin, granulated.
27. Turmeric, Tincture, and Paper.

And the following *Test Solutions:*—

Solution of—

28. Acetate of Copper.
29. „ Potash.
30. „ Soda.
31. Albumin.
32. Ammonio-nitrate of Silver.
33. „ sulphate Copper.
34. „ „ Magnesia.
35. Boracic Acid.
36. Bromine.
37. Carbonate of Ammonia.
38. Chloride of Ammonium.
39. „ Barium.
40. „ Calcium.
41. „ Calcium (saturated).
42. Chloride of Gold.
43. „ Tin.
44. Gelatin.
45. Iodate of Potash.
46. Iodide of Potassium.
47. Oxalate of Ammonia.
48. Perchloride of Platinum.
49. Phosphate of Soda.
50. Red Prussiate of Potash.
51. Sulphate of Indigo.
52. „ Iron.
53. „ Lime.
54. Sulphide of Ammonium.
55. Tartaric Acid.
56. Yellow Prussiate of Potash.

TEMPERATURE.

Temperature in all cases, excepting where otherwise stated, is to be determined by Fahrenheit's thermometer, and the degrees mentioned in this work have reference to this scale alone. Specific gravities are to be taken at 60°.

WATER.

Wherever water is mentioned in the following pages, "distilled" or pure water is intended.

WATER BATH AND STEAM BATH.

When a *water bath* is directed to be used, it is to be understood that this term refers to an apparatus by means of which water or its vapour, at a temperature not exceeding 212°, is applied to the outer surface of a vessel containing the substances to be heated.

In the *steam bath* the vapour of water, at a temperature above 212°, but not exceeding 230°, is similarly applied.

PHARMACEUTICAL AND CHEMICAL OPERATIONS.

Natural productions are for the most part unfit for immediate use as medicines, and they have therefore to undergo a variety of preparatory processes; these relate to the selection, preparation, and preservation of drugs.

The Selection of Drugs.

This implies a knowledge of their *physical properties*, such as colour, odour, taste, form, consistence, density, fracture, solubility, &c.; and also of their chemical characters, and the means of detecting impurities and adulterations. In the selection of vegetable substances, attention must be given to the influence of season, locality, age, cultivation, &c.

The Preparation of Drugs.

This has reference to a great variety of operations. These are as follows:—

1. The Reduction of Substances to Fragments or Powder.—These are expressed by the terms *contusion* (*contundo*, to bruise, to crush, to press), and *pulverisation* (F. *pulvériser*, to reduce to powder; from *pulvis*, dust). Contusion is employed to break down the cohesion of fibrous roots, such as rhubarb, in order to allow the access of the solvent to every part. Cutting is sometimes substituted for this process. Pulverisation is one of the most important of Pharmaceutical operations. This is illustrated by the inertness of mercury in mass, and its potent action in a state of minute subdivision. It may be effected by *trituration* (*tero*, to rub, whence *trituro*), with a pestle and mortar, or by *precipitation* (*præceps*, whence *præcipito*, to cast down). These two modes of obtaining a powder are well illustrated in the preparation of the two varieties of red oxyde of mercury. *Levigation* (*levis*, smooth, and *ago*, to make), is the process by which powders are reduced to the finest possible condition; it is usually effected by triturating the substance with water, or in any fluid in which the solid is insoluble.

Vegetable substances are commonly reduced to powder by grinding in iron mills, or crushing by stone rollers. Metals are reduced to a state of subdivision by *filing*, as iron, or *granulation* (F. *granuler*, to form into grains, from *granum*), as zinc and tin. Granulation of these metals is effected by pouring the fused mass in a thin stream from a height, into a large body of cold water.

When a large quantity of a substance is partially reduced to powder, two means are adopted for separating the coarser particles, if it be a vegetable substance, the process of *sifting* through hair, wire, or gauze sieves, which are numbered according to the closeness of the meshes, is resorted to. But when the substance is a mineral and insoluble in water, the simple process of *elutriation* (*eluo* or *elutrio*, to wash out) is conveniently adopted. This is exemplified in the preparation of Creta præparata and the non-officinal Calamina præparata. It consists in stirring the powder with water, and after the subsidence of the larger particles, pouring off the milky or turbid fluid containing the finest, and then allowing these to subside, when the water is poured off, the sediment drained, and lastly dried.

2. THE SEPARATION OF FLUIDS AND SOLIDS.—This may be effected, as just mentioned, by *deposition* (*depono*, to put down) of the solid, and *decantation* (*decanto*, to pour off gently) of the fluid. The latter process may be effected by simply pouring off the fluid if the deposit be heavy, but if not it is best to use a syphon, the immersed end of which should be gradually lowered as the liquid flows away, for if it be brought too near the deposit the suction action causes a rise in the latter. To prevent this, the end of the syphon should be closed, and an aperture or two made in the sides so as to induce a lateral, instead of an upward current. This process is illustrated in the preparation of Bismuthi subnitras, Ferri carbonas saccharata, &c. But the commonest process for the separation of solids and fluids is the *filter* (F. *filtre*, a strainer). *Filtration* (figs. 4, 5), unless otherwise directed, is effected by means of white bibulous paper, sufficiently strong to support the weight of the fluid, and of close texture so as to prevent the passage of fine particles, and composed of pure cellulose. When the deposit is very finely divided (as, for example, precipitated chloride of silver), the filter should be wetted before the mixture is placed in it, in order to decrease the size of the pores. Fig. 5 shows the mode of washing a precipitate. The stream of water should be directed around the margin of the paper. Calico filters are often employed when the object is the washing and preservation of the deposit, because the filtration can be more readily effected than with paper, and the water can be removed by wringing. Powdered glass (*e.g.* for Liquor potassæ), sand, and powdered charcoal (*e.g.*, for

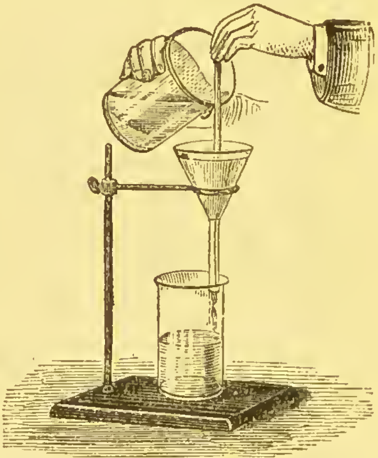


Fig. 4.

alkaloids) are occasionally employed as filters, the former two substances when paper or calico are destroyed by the filtrate, and the latter for the purpose of decolorising the filtrate. Evaporation, and occasionally desiccation and distillation, are also employed in order to separate fluids and solids.

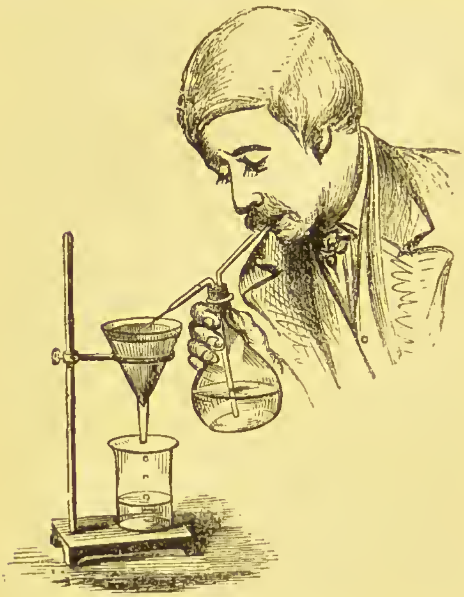


Fig 5.

3. EVAPORATION (*evaporo*, to pass off in vapour) is more commonly employed to increase the strength of certain liquids, or to convert them into solids, as in the preparation of liquid or solid vegetable extracts, and in the formation of crystals. Evaporation may be effected *spontaneously*, *i.e.*, by exposure in a dry air at the natural temperature, or at any temperature between this and the boiling point of the fluid. In the preparation of vegetable extracts, the efficacy of which frequently depends on some easily decomposed or even volatile principle, it is necessary to avoid a high temperature, and to effect the required evaporation as quickly as possible. The Pharmacopæia prescribes a water bath, and a temperature not exceeding 140°, but careful manufacturers employ vacuum pans for the preparation of extracts. The rate of evaporation is greatly influenced by increase or diminution of atmospheric pressure, by the quantity of aqueous vapour in the air, and the extent of surface exposed; and the conditions most favourable to the process are—1, the exposure of a large surface; 2, constant stirring, to facilitate the separation of vapour; 3, a free current of dry air; 4, increase of temperature, or diminution of atmospheric pressure, for these have the same effect. But since the boiling point is reduced by removal of atmospheric pressure, evaporation in vacuo is the best means of securing an active preparation. Evaporation, on a small scale, is best effected by a steam bath of the following form (fig. 7). By means of the little reservoir in which the supply tube ends, the water will

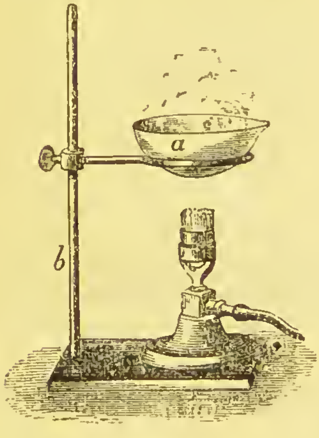


Fig. 6.

always maintain the same level, no matter how long the heat be applied or how rapid the ebullition, provided, of course, the trickle of water be continuous, and this is easily effected, as a comparatively small quantity is required to supply the place of that lost by evaporation. When a higher degree of heat is required, as in the preparation of the hydragyri oxydum rubrum, the naked flame may be used (fig. 6).

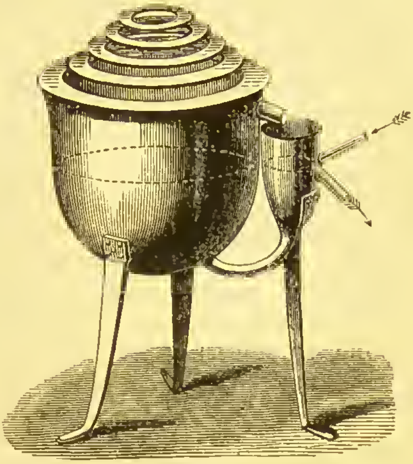


Fig. 7.

4. The Expression of Vegetable Juices.—This is most economically effected by means of a powerful hydraulic press, which completely removes the juice, reducing the vegetable tissue to a dry cake. The picked leaves or cleansed roots should be previously crushed between rollers, or by the more tedious process prescribed in the Pharmacopiæ, viz., bruising in a stone mortar. Under a pressure of 100 tons, leaves yield according to their succulency, from 75 to 50 per cent. of their weight of juice.

5. Clarification or Despumation (*despumo*, to take off the scum), may be effected in the case of honey, for example, by heating and skimming; or if this be insufficient, by the addition of white of egg or isinglass; the former carries any floating particles to the top, when the fluid is heated, the latter forms a kind of descending strainer which carries the particles to the bottom; the impurity being separated in the one case by skimming, and in the other by decantation.

6. Solution.—Solubility is a most important property, for so long as a substance remains insoluble, it is usually inert; active properties, however, are frequently developed by reducing the substance to an impalpable powder. This is the case with mercury, platinum, &c. Solution is effected when the cohesion of the particles of the solid is overcome by their adhesion for water, alcohol, ether, &c., and it is, of course, greatly facilitated by conditions which destroy the force of cohesion; these are pulverisation, agitation, and heat. A few substances—the hydrates and carbonates of lime, baryta, magnesia—are abnormal with regard to temperature, being more soluble in cold water than in hot. Water is the general solvent for salts, albumin, gelatin, sugars, gums, and nitrogenised organic substances. Alcohol, æther, chloroform, and benzol, for a few haloid salts, the fatty and resinous hydrocarbons, essential oils, the active principles of plants, and the alkaloids generally. Oil is a solvent for sulphur, phosphorus, camphor, and the essential oils. Glycerine is a powerful solvent for many substances which are only moderately or not

at all soluble in water and alcohol. A solvent has no chemical action on the substance dissolved, but solution greatly facilitates chemical action by bringing the particles of different substances into the most perfect contact. This is exemplified by tartaric acid and carbonate of soda, which may be kept simply mixed in the form of fine dry powder for an indefinite length of time; but the moment it is thrown into water it dissolves, the particles are brought into closer contact than they were before, and chemical union occurs. When a solvent has dissolved as much as it is able to do at a given temperature, the solution is *saturated* for that temperature, and for all degrees below it; but if a rise of temperature should occur, the solution is no longer saturated, but will take up more of the soluble body. Solutions are effected by (*a*) *Ebullition* (*ebullio*, to bubble up), the bubbles being composed of masses of vapour, which, the pressure of the air being equal, is formed always at the same temperature for the same fluid, and thus the boiling point is one of the distinctive characters of a given liquid. Æther boils at 94°·8, alcohol at 173°·1, water at 212°, oil of turpentine at 316°, mercury at 662°; a saturated solution of chloride of calcium at 355°; a saturated solution of chloride of sodium at 229°·5. *Decoctions* (*decoquo*, to boil) are confined to vegetable preparations, which are boiled in water until they are exhausted of their active principles. They should be strained hot, as some portion of the active principle may be deposited on cooling. When the plant owes its virtue to a volatile substance, this must be extracted by one or other of the following processes, because the active principle would be dissipated by boiling:—(*b.*) *Infusion* (*infundo*, to pour upon), a solution formed by pouring water, either hot or cold, upon a vegetable substance, and allowing them to remain in contact for a time. Hot water has the advantage of dissolving active principles more readily and completely than cold, but cold water is occasionally employed (*e.g.*, infusum calumbæ) in order to avoid the solution of starch, which renders the infusion liable to speedy decomposition. In the case of Chiretta and Cusparia, bitter aromatic substances, water at 120° is prescribed. The bitter aromatic principles of these plants are generally diffused, and are soluble in warm water; Buchu, on the other hand, though its active principle is volatile, requires boiling water both to soften the tissues in which it is stored, and to dissolve it. It contains, moreover, an excess of volatile oil, so that the loss of a portion by the use of heat is of no importance. (*c.*) *Maceration* (*macero*, to soak) is a solution formed slowly (during some hours or days) at the ordinary temperature of the air, *i.e*, from 60° to 80°. The term is usually applied to the formation of spirituous, acetous, or ætherial solutions of vegetable substances called tinctures, wines, and vinegars. Agitation should be employed occasionally during the maceration. (*d.*) *Percolation*, or the slow filtration of fresh portions of the solvent through the vegetable matter, is necessary for the purpose of exhausting it of its soluble matters. Fig. 8 represents a good form of percolator (that of the York Glass Company). The lower aperture of the upper chamber should be closed with a piece of wash-leather or flannel, and upon this a layer, $\frac{1}{2}$ to 1 inch thick, of washed silver sand. The ingredients to be exhausted, previously subdivided or powdered, are then closely packed in this vessel, and a small disc of glass placed on the top of the mass, if it be in a fine state of subdivision. By means of a glass rod the spirit can be directed upon this without causing any disturbance of the mass below, and it flows off equally in all directions. The stopper and neck E of the upper vessel are each grooved a little more than half way, so as to form when in line a complete groove by means of which air may pass; the inserted portion of the upper vessel and the neck E of the lower have the same arrangement. By closing both grooves percolation is at once converted into maceration, and *vice versâ*. (*e.*) *Digestion* (*digero*, to dissolve) is a prolonged infusion or maceration usually effected at a moderate temperature of about 100°.

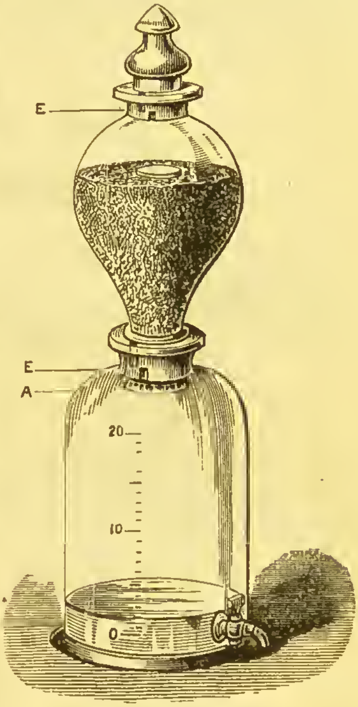


Fig. 8.

7. Distillation (*destillo*, to trickle down). By this process volatile liquids are separated from solids or liquids, which are either fixed or less volatile than themselves. It consists of two processes—ebullition, by which the fluid is volatilised, and condensation, by which it is again reduced to the liquid form. For the distillation of water, aromatic waters, and alcohol, the retort or still may be of iron, copper, tin, earthenware, or glass, but the worm or condenser should be of tin or glass; leaden pipes must be scrupulously avoided (see action of water on lead). Glass retorts of hard German glass are used for the distillation of the volatile acids, chloroform, &c.; and the best form of condenser is that which bears the name of Liebig, fig. 9. A stream of cold water is admitted below, and becoming heated in its upward progress, flows out above.

The *condensation of gases*, such as Carbonic acid, Chlorine, Ammonia, and Hydrochloric acid, is effected by conducting them into water, in which they become dissolved.

8. Sublimation (*sublimo*, to raise) or dry distillation, is employed to separate volatile from non-volatile solids. It is employed in the preparation of Iodine, Sulphur, Chloride of Ammonium, Calomel, Corrosive sublimate, Camphor, &c.

Complete Volatilisation is a test of the purity of salts of mercury, and of the oxydes and sulphides of arsenic and antimony; and the form in which the vapour is deposited is a means of distinguishing the sesquioxyde of arsenic from that of antimony. Volatilisation and reduction are readily effected by the blow-pipe flame. In order to effect the latter process as in the case of salts of Silver, Lead, Bismuth, the metallic salt is brought in contact with the point R of the inner blue flame. In fig. 10, A indicates the hollow part of the flame occupied by air; R, the reducing point; and O, the oxydising point.

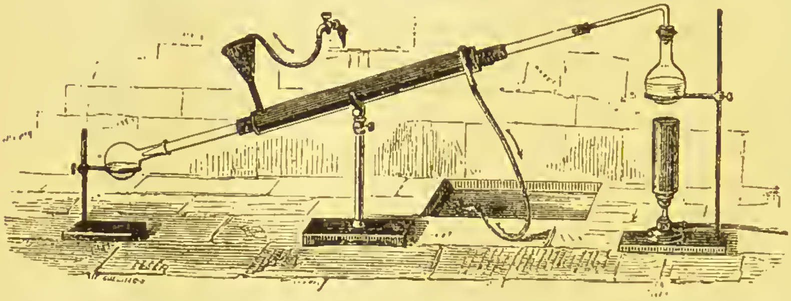


Fig. 9.

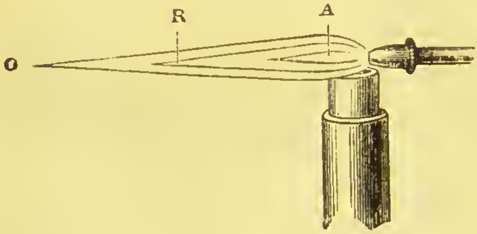


Fig. 10.

9. Fusion (*fundo*, to cause to flow) is a process required to deprive caustic alkalies and some salts of water, and to allow of their being cast into moulds. It is also employed for the purposes of decomposition, as in the preparation of the Prussiate, and Permanganate of potash, &c. Fusion is also a means of purifying certain metals, *e.g.* Bismuth. Fig. 11 represents a simple and efficient gas furnace, by means of which the operation can be readily performed and inspected. The three handles indicate the component parts of the furnace which may be easily detached, and united during an operation. The mixture of gas and air is regulated, and the combustion effected by means of a compound Bunsen's burner.

Fusion is commonly effected in Hessian crucibles, but these cannot be used when oxyde of lead is present, because it forms an easily fusible glass when heated with silica—the chief constituent of earthen crucibles. Alkalies also attack silicious and platinum crucibles; iron or silver crucibles must, therefore, be used for the fusion of these substances.

10. Precipitation is the process by which the metallic oxydes and the alkaloids are separated in the amorphous state from the solution of their salts. This is effected by the addition of some alkali. In the case of the metallic salts it is necessary, in order to secure uniform

results, to keep the alkali always in excess, and this is done by adding the former to the latter.

In testing the characters and in ascertaining the purity of drugs, the occurrence of a precipitate, and its nature and behaviour with the precipitant or some other reagent, is the usual means of determining these questions. The precipitate rarely has a crystalline form, but this is the case with triple phosphate, oxalate of lime, and acid tartrate of potash.

11. Desiccation (*desicco*, to dry). Some salts and precipitates (*e.g.* Valerianate of zinc) must be dried at the ordinary temperature of the air. The greater number are not decomposed at 212°; and as it is desirable to dry certain of them as rapidly, and with as little exposure to the air as possible, a steam closet, fig. 12 (*c* is a little reservoir by means of which, as in fig. 7, p. 19, water is supplied to take the place of that lost by evaporation at *f*, and the fluid is maintained at the same level by the supply and waste pipes) should be used for this purpose. Deliquescent crystals may be formed, or dried over a dish of sulphuric acid, and enclosed under a glass shade, the edge of which is ground, and retained in air-tight contact with a plate of glass upon which it rests, by means of a little lard. Liquids are deprived of moisture by the following hygroscopic substances: freshly burnt lime, dry carbonate of potash (see Alcohol), fused chloride of calcium (see Æther), and sulphuric acid. Gases are dried by allowing them to pass through a tube (fig. 13), containing fragments of fused chloride of calcium (*a*), or of pumice stone moistened with sulphuric acid (*b*).

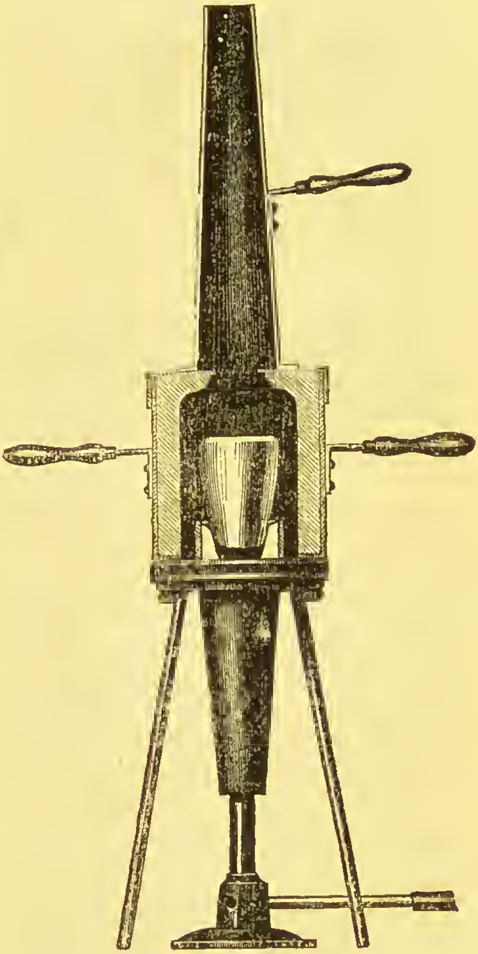


Fig. 11.

12. Specific Gravity or Density.—By this is meant the weight of any substance as compared with the weight of an equal bulk of a standard body. Equal bulks of different bodies differ much in weight, as, for instance, lead and cork, in consequence of the former containing more

matter in the same space than the latter; or, in other words, lead has a greater *density* than cork. Bodies are, therefore, weighed under two points of view: first, with respect to their absolute weights, and secondly, with reference to that which is peculiar to each *species*, and is hence called *Specific gravity.* As the quantity of matter within the same space differs very much according as it is more or less expanded by heat, so the Sp. gr. of bodies is always referred to one temperature, that is 60°. The quantity of a medicinal substance, as of an acid, an alkali, or a spirit, may, moreover, vary very much in the same bulk according as it is more or less diluted with water. And as this fluid will be either lighter or heavier than water, its solution will thus be heavier or lighter, exactly according to the degree of dilution. The strength, therefore, which is the same thing as the Sp. gr., requires to be ascertained, both for Pharmaceutical and for Medicinal purposes. Water is, for convenience, taken as the standard to which the comparative weights of other bodies are referred; but its Sp. gr., though usually reckoned as 1, is by some taken at 1000, to avoid fractional parts.

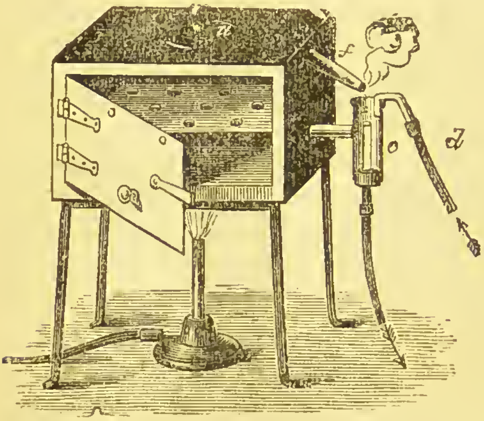


Fig. 12.

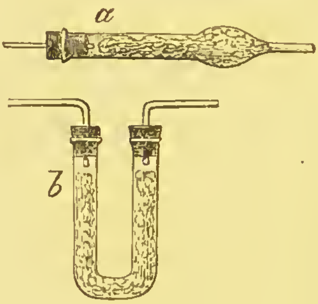


Fig. 13.

The Sp. gr. of a liquid may easily be ascertained by weighing it in a bottle which holds exactly 1000 grains of water at 60° (fig. 14). Solids are weighed first in air, and then, when suspended by a hair, in water (fig. 15). In this case, they displace a quantity of water equal to their own bulk, and weigh less than in air, because they are supported by the surrounding water with a force equal to the weight of water which has been displaced. So that the loss in the weight will denote the weight of an equal bulk of water. This then is the rule: find the difference between the weight of the body in air, and when weighed in water; take this difference to divide the weight of the body in air, and the quotient will be the specific gravity. The Sp. gr. of aëriform bodies is ascertained by weighing certain measured quantities when passed into a vessel exhausted of air, and of which the weight has been previously ascertained. The different gases vary much in their Sp. gr., but they are all referred to Atmospheric air as a standard. By careful experiment, it has been found that 100 cubic inches of air weigh 31·0177 grains at 60° of temperature and 30 inches of barometrical pressure.

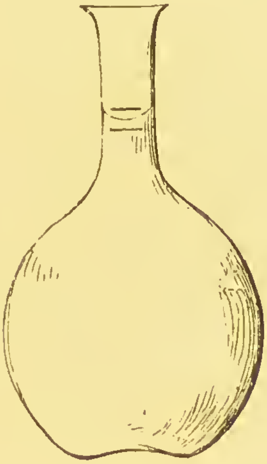


Fig. 14.

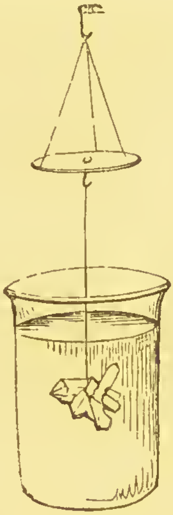


Fig. 15.

Daniell has given the following table of the Sp. gr. of the lightest gas, of air, of steam, and of water:—

Cubic inches.	Weights, Grains.	Sp. gr. Air 1.	Sp. gr. Water 1.
Hydrogen 100	2·136	0·0694	0·0000846
Air . . 100	31·000	1·0000	0·0012277
Steam . 100	19·220	0·6240	0·0007611
Water . 100	25250·000	814·0000	1·0000000

13. CRYSTALLISATION.—When bodies in passing from the liquid or gaseous state assume regular geometrical forms, the process is called *crystallisation*, and the solid bodies, *crystals*. This may be effected by gradually cooling down any melted mass, as sulphur, the metals; or a vapour, as sal ammoniac or corrosive sublimate; or by slowly evaporating the liquid in which a solid is dissolved. This latter process then, depending on evaporation, requires to be performed in broad and shallow vessels. It is favoured by the presence of foreign bodies, &c., and by agitation; but the crystals then produced are small, as also when the process is quickly performed.

The majority of crystals, when deposited from their watery solutions, carry with them a certain portion of water, which they render solid, but much of which they also part with by the mere application of heat or by exposure to the air. This is called *water of crys-*

tallisation, and it exists in crystals in its equivalent proportion, or some multiple of it. A salt or body *combined* with water is called a *hydrate*, one without any, *anhydrous*. Salts which contain much water of crystallisation, when heated, undergo aqueous fusion, and, the water being dissipated, they are left as dry salts: *e.g.* burnt alum. Some, when exposed to the air, lose this water, and are said to *effloresce;* others absorb water, and are said to *deliquesce;* while those which undergo no change in the air are called *permanent.*

Crystals are classified according to their forms, and as these are limited, it happens that several substances crystallise in the same form. They are then said to be *isomorphous*; thus the sulphates of magnesia and zinc are isomorphous. The forms of crystals have been distinguished into those which are *Primary*, and others which, from being considered as modifications of them, are called *Secondary*. That the *external forms* are connected with a certain regularity of *internal structure*, is evident from the well-known facts of the *cleavage* of crystals, also their refraction of light and different degrees of expansion by heat. Crystallography is founded upon the regular and exactly similar distribution of two, three, four, or any number of parts in symmetrical order; and on the law that if one of the primary planes or axes of a crystal be modified in any manner, all the symmetrical planes and axes must be modified in the same manner.

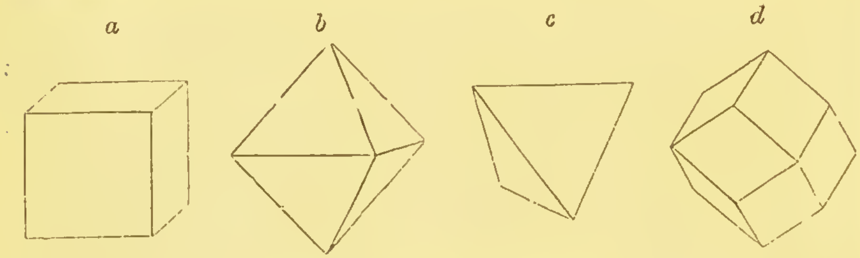


Fig. 16.—Cubic or Regular System.

The introduction of a systematic arrangement of crystalline forms, according to their degrees of symmetry, is due to the labours of Weiss and Mohs, and its principles are explained in Daniell's Introduction to Chemical Philosophy.

1. *The Cubic* or *Regular System.*—This is characterised by three axes, all equal, and at right angles to each other. The principal forms are the *cube* (*a*), of which the chlorides, bromides, and iodides of the alkaline metals, fluorides of calcium, and iron pyrites, are examples; the *regular octahedron* (*b*), illustrated by alum, arsenious acid, magnetic iron ore, diamond; the *tetrahedron* (*c*), an occasional form of copper and arsenious acid; and the *rhombic dodecahedron* (*d*), of which garnet is an example.

2. *The Right Square Prismatic System*, characterised by three axes, all at right angles to each other, but only two of them equal, the third being longer or shorter (fig. 17). The principal forms are two

prisms with a square base (*e.g.* oxyde of tin and cyanide of mercury), and two octohedra, *direct* when the axes end in the angles, and *inverse* when they end in the edges. When the third axis is shorter than the other two, a square plate (*e.g.* ferrocyanide of potassium) results.

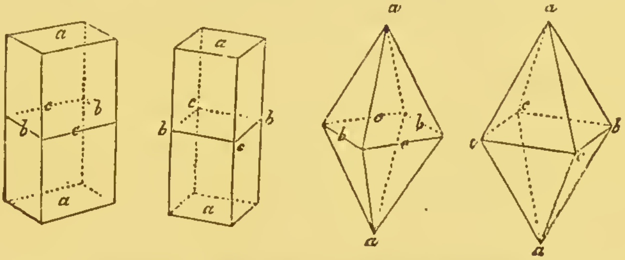
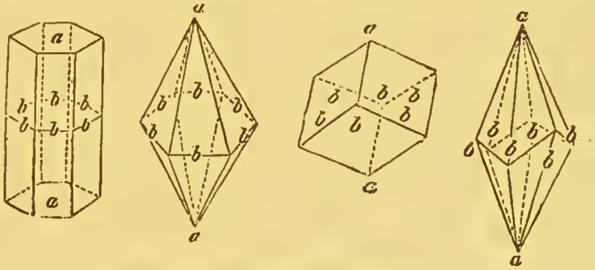


Fig. 17.—Right Square Prismatic System.

3. *Rhombohedral System.*—Four axes, three of equal length, in the same plane, and placed at angles of 60° to each other, and the remaining axis *a*, *a*, longer or shorter and perpendicular to the others (fig. 18). The principal forms are the *rhombohedron* (Iceland or calx spar), the *bipyramidal dodecahedron*, direct and inverse (beryl), and the six-sided prism (quartz, nitrate of soda, ice) or six-sided plate (plumbago—a form of carbon).



Fig, 18.—Rhombohedral System.

4. *The Right Rectangular Prismatic System.*—Three axes all at right angles, but all unequal, and usually having no proportion to each other (fig. 19). The principal forms are the *right rhombic* (based)

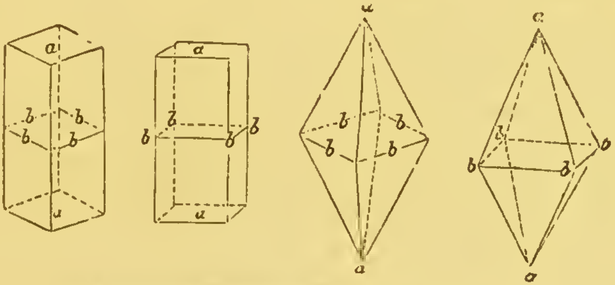


Fig. 19.—Right Rectangular Prismatic System.

prism (nitrate of potash, sulphate of baryta), and the *right rhombic octohedron* (sulphur crystallised from bisulphide of carbon, topaz, aragonite—a form of carbonate of lime).

5. *The Oblique Prismatic System.*—Three axes, all of which may be unequal, two cross each other obliquely, the third *a, a,* is perperdicular to both (fig. 20). The chief forms are the *oblique rhombic prism* (sulphate, phosphate, and bicarbonate of soda, sulphate of iron, sulphur crystallised by fusion and slow cooling), and the *oblique rhombic octohedron.*

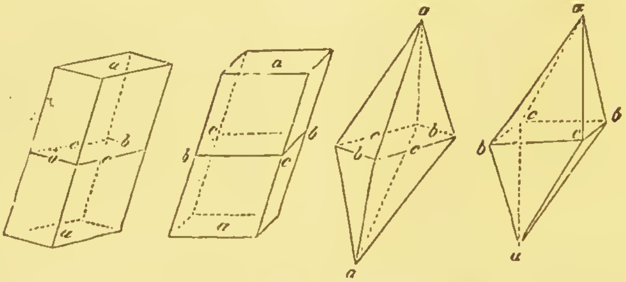


Fig. 20.—Oblique Prismatic System.

6. *The Doubly Oblique Prismatic System.*—Three axes all unequal, and all placed obliquely to one another. The principal forms are the *doubly oblique prism* (sulphate of copper and nitrate of bismuth), and the *doubly oblique octohedron.*

Some substances crystallise in forms which belong to two or even three different systems, and these are called dimorphous and trimorphous bodies respectively. Carbon, sulphur, carbonate of lime, and red iodide of mercury are dimorphous substances; sulphate of zinc is trimorphous.

The Preservation of Drugs.

Much care is required in the preservation of drugs, and whenever it can be so arranged, the place where they are kept for immediate use should have a north aspect, in order to *exclude the direct rays of the sun,* which have a powerful decomposing influence upon many medicines; and this is greatly increased by the presence of impurity, or by admixture with other substances. Thus nitrate of silver or its solution, when *absolutely pure,* will bear prolonged exposure to sunlight without discoloration, but the presence of a mere trace of organic impurity determines its partial decomposition. This simple fact has direct bearing on the preservation of such mixtures as calomel and rhubarb; and, as a rule, these should be freshly prepared. Drugs of all kinds should be stored in a dark, cool, and dry chamber, where the temperature varies as little as possible. The substances on which light has a rapid decomposing influence are the precipitated black and red oxydes of mercury, green iodide of mercury, oxyde of silver, salts of silver, generally, and hydrocyanic acid. These, therefore, should be kept in bottles composed of dark violet-coloured glass, in order to exclude the chemical rays of the spectrum, and put away in a dark closet.

The exclusion of air is, generally speaking, of even more importance than that of light, for it implies the exclusion of oxygen, carbonic acid, and water. Thus hydrocyanic acid and æther rapidly decomposes on exposure to the air from absorption of oxygen. The caustic alkalies, lime and magnesia, are converted into carbonates or oxycarbonates from absorption of carbonic anhydride; the caustic alkalies, the chlorides of sodium, potassium, calcium, zinc, carbonate of potash, sulphuric acid, glycerine, and alcohol, greedily absorb water, even from a moderately dry air. Substances, on the other hand, require to be secured in air-tight vessels, in order to prevent the evaporation of volatile matters, and the deterioration caused by frequent atmospheric changes. Very volatile liquids, such as æther, chloroform, benzol, hydrosulphate of ammonia, are scarcely to be retained by the most accurately fitting stoppers, and the bottles containing them should, therefore, be provided with caps, which not only afford a further security against evaporation, but if properly fitted, prevent jumping of the stopper, which is apt to occur with increase of temperature. Volumetric solutions, for an obvious reason, should be preserved in such bottles. Even certain salts become altered in strength by loss of water of crystallisation from exposure to the air; this is the case with most of the salts of soda, notably the sulphate and phosphate, sulphate of zinc, and acetate of lead, which effloresce in moderately dry air.

All vegetable substances suffer from exposure to a moist air, they should therefore always be preserved, after careful drying, in well-covered tin vessels. The more perishable, such as the leaves of henbane, hemlock, digitalis, and the flowers of the rose and chamomile, require the greatest care both in collecting, drying, and keeping; they should be preserved in a dry, but not a warm place, and be renewed annually.

Prescribing and Dispensing.

A few words on these topics and on the relative duties of the prescriber and dispenser will form an appropriate conclusion to this section.

Prescribing.—Experience dictates and science requires attention to the following rules:—1. The prescriber should refuse conversation with his patient when he is writing the prescription, and he should read it carefully through before giving it to the patient. 2. He should affix his initials and full address, and the date to every prescription; for the latter is useful for reference to all the parties concerned, and the former is necessary to allow the dispenser to communicate with the prescriber, in case of obscurity or obvious error in the prescription. 3. The directions should be written in English, the rest of the prescription in unabbreviated Latin. The utility of the present Pharmacopœia is marred by the use of the English language, instead of the more widely-known Latin. A free and increasing intercourse with the Continent renders the use of Latin in prescribing necessary, and for the same reason some knowledge of the German and French Pharmacopœias is very desirable. Both at home and abroad it is an element of safety that the patient should be able to read the directions contained in his prescriptions. 4. When an unusually large dose is required, the anxiety of the dispenser should be relieved by an accompanying explanation such as the following:—℞ Morphiæ acetatis, grana x. (10 grs.), or Morphiæ acetatis, gr. x. (!) 5. It is the duty of the prescriber to diminish the risk of danger in dispensing. The Pharmacopœia has very wisely ordered moderately dilute solutions of the most poisonous drugs. Thus there are solutions of strychnia, atropia, morphia, of arsenic and corrosive sublimate, and in all but exceptional cases these should be invariably prescribed; and when the exceptional case presents itself, the prescriber should show his sense of responsibility by using the greatest care in writing his prescription, by which he may hope to arouse attention, if, as happens to all, a momentary forgetfulness should affect the dispenser when the prescription comes before him. 6. Follow simplicity, remembering that any considerable departure from it betrays an ignorance of the action and use of drugs. If a given medicine be always given in combination with others, it is impossible to obtain this knowledge, and the lack of it must constantly lead the prescriber astray, and in the end destroy his confidence in the beneficial influences of medicine. What is here meant is not the combination of two or more drugs which possess a similar or somewhat similar action, such for example as opium and chloral hydrate, opium and hemlock, but that little good can be expected, either in the form of relief to the patient or of information to the prescriber, from a jumble of medicines, when not one of them is present in sufficient quantity to induce its individual effects. 7. In prescribing disagreeable medicines, diligent attention should be given to the means of making them, if not pleasant, at least sufficiently palatable to allow of their being taken without inducing disgust or nausea. The Pharmacopœia has provided abundant means for this purpose, but the ingenuity of the prescriber will often be greatly taxed to effect it. Still much may be done; Liquorice, we know, completely deprives aloes of its bitter taste without injuring its purgative power. Salt and pepper are often advantageous combined with oil to render them palatable. Sugar and the process of emulsification will remove both the taste and the objectionable appearance of an oil. Castor oil being soluble in alcohol, may be given with a little neat brandy, the ardent taste and aromatic flavour of which obscures to a great extent the greasy taste of the oil. Saline preparations, such as Epsom salts, acetate of ammonia, &c., become tolerable in proportion as they are diluted with water, Strong flavours may often be tempered and diverted by the addition of a similar but more agreeable flavour; while they are usually made more disagreeable, by the futile attempt to cover them by some equally strong but more familiar aroma. Nor must we forget that delicate persons have often very opposite feelings with regard to cinnamon, peppermint, chloroform, and the like.

Dispensing.—Our remarks on this subject must be very few, and chiefly with reference to care and attention:—

1. Every medical man should be practically familiar with dispensing, for without this knowledge it is impossible that he can prescribe properly.

2. In accordance with a wise practice now very generally adopted, all poisonous drugs should be kept in grooved bottles, so that if the *eye* be inattentive, the *hand* may know that it holds a poison.

3. The poisonous alkaloids, prussic acid, corrosive sublimate, the cyanides of potassium and mercury, and the preparations of arsenic, should be kept in a locked closet, and it should never be unlocked for the purpose of dispensing except in the presence of another competent witness. When excessive caution is required, the dispenser should never trust to his own attention; he should be checked in every stage of the process by the observation of a second person. This precaution especially applies to the preparation of the solutions of the alkaloids, arsenic, and perchlorides of mercury prescribed in the Pharmacopæia.

4. When an excessively poisonous drug, such as strychnia, is ordered in the form of pill, it should, when soluble, be reduced to the fluid condition, in order that it may be uniformly diffused through the mass.

5. If there be any doubt as to the meaning of the prescriber,—if the dose be excessive, and not clearly indicated as such,—or if there be an actual error in the prescription, the dispenser should at once communicate with the prescriber, and clear up all ambiguity before he delivers the medicine to the patient.

MUTUAL RELATIONS OF THE PRESCRIBER AND DISPENSER.

Whenever it is practicable, the prescriber should be his own dispenser. The relation between a medical man and his patient is naturally of the most confidential kind, and it is sometimes with reluctance that the former directs and the latter accepts the intervention of a third person in the capacity of a dispenser, for both are aware that inferences as to the nature of the complaint may be formed from the prescription; nor is the matter mended by a knowledge that the inference may be incorrect.

But the medical man has other inducements to dispense his own prescriptions,—he has a personal interest in them, and that sense of security which a man of sound sense has in his own work: and in sending his prescriptions to another, he feels the force of the old aphorism, "There's many a slip between the cup and the lip," and believes that the chances of a slip are diminished when the medicine is sent out under his own supervision. If the medicine be obtained from an unknown source, and the action repeatedly fails, he must infer either that the condition of the patient obstructs the action of the drug, or that the drug is inefficient. Some experience of this latter contingency will rarely be wanting to give strong bias to his conclusion. This may nevertheless be unjust; but anyhow an element of confusion is imported into the case, alike unsatisfactory to each of the three parties concerned. Had the medical man sent his patient a preparation with the individual action of which he was familiar, doubts would never have arisen, but, on the contrary, he may have added an useful fact to medical science. But further, when a medical man entrusts the prescription to his patient, a very long interval may elapse before he returns, and then he may be found suffering not so much from the disease as from the abuse of his medicine; or he may never return, choosing to be guided by his own discretion, or by the advice of the dispenser as to the need of continuing or omitting the use of the medicine. By such a course as this the influence of the prescriber is weakened, and it may be that his usefulness is prevented by the patient, who is not unseldom ready to recommend the use of his prescription for the relief of every ailment that he fancies has any similarity to his own.

The foregoing considerations suggest the relations which should subsist between the prescriber and dispenser. Patients constantly place the druggist in a very unpleasant position; they catechise him on the composition and action of the medicine prescribed. "Is it poisonous?" "It does not contain opium, I hope?" "May I give a dose to my child?" &c., &c. Now it is easy to answer these questions, indeed, the difficulty is to avoid an answer; but it is plain that no other answer should be given in any case but this—"Pardon me that I cannot answer a single question you put to me respecting this medicine. I am in honour bound to refer you to the person who prescribed it, and he, I am sure, will give you the information you seek, if he thinks it is to your advantage to possess it."

As often as confidence is thus established between the prescriber and dispenser, the former will do well to intrust the greater portion of his prescriptions to the latter; but it is undoubtedly desirable that the general practitioner should be able to dispense conveniently and expeditiously certain of his own prescriptions, for it will often be an advantage to his patient and himself that he should do so.

MATERIA MEDICA.

PART FIRST.

INORGANIC KINGDOM.

MEDICINAL substances derived from the inorganic kingdom are, chemically speaking, both *simple* and *compound;* and as the latter are built up of the former, a knowledge of the elementary bodies forms a necessary as well as a natural stepping-stone to the history of their compounds. While we shall adopt this order in our study of the Materia Medica, it will nevertheless be convenient to give to the two commonest compounds, *Air* and *Water*, the foremost place, on account of their importance and ubiquity.

ATMOSPHERIC AIR.

L. *Aër.* F. *Air Atmospherique.* G. *Atmosphärische Luft.*

The Atmosphere, which invests the globe, extends to a height of 45 miles. It is an invisible gas, devoid of odour and of taste. Being taken as the standard of comparison for gases, its sp. gr. is reckoned =1. 100 cubic inches weigh 31·0117 grains, and its pressure at the level of the sea is equal to 15 pounds upon each square inch of surface, or a column of air one inch square, and extending to the limits of the atmosphere, weighs 15 pounds, or the same as a column of mercury, also one inch square, but only 30 inches high, which it is thus able to balance by the pressure of its weight. This weight must necessarily vary at great depths, as well as at great heights, as a greater or less mass of air will be superimposed. Hence the barometer is employed for measuring heights, a diminution of one inch being found equal to about 1000 (922) feet. As it is compressible, its density necessarily varies at different heights, the inferior strata being dense, and the upper ones rarefied. If the air be examined at a series of heights, increasing in the arithmetrical progression of 3·4 miles from the sea-level, the density of the air, and consequently the height of the barometer, *decreases* in the geometrical progression of ½, while the bulk of equal weights of air *increases* in the geometrical progression of 2; thus—

Density of the Air at Increasing Elevations.

Miles above Sea.	Bulk of Equal Weights of Air.	Density.	Height of Barometer.
0	1	1	30·00 inches.
3·4	2	$\frac{1}{2}$	15·00 ,,
6·8	4	$\frac{1}{4}$	7·50 ,,
10·2	8	$\frac{1}{8}$	3·75 ,,
13·6	16	$\frac{1}{16}$	1·87 ,,
17·0	32	$\frac{1}{32}$	0·93 ,,

The temperature also diminishes as we ascend into the atmosphere, at the rate of 1° Fahr. for every 100 yards, or, more correctly, for every 352 feet; on the other hand, it increases 1° Fahr. for every 50 feet of descent below the sea-level.

The air is composed of a *mixture* of Oxygen and Nitrogen, and small portions of Water and Carbonic acid. The proportions in which these exist are, in 100 parts:

Nitrogen gas, .	77·5	by measure,	75·55	by weight.
Oxygen gas, .	21	,,	23·32	,,
Aqueous vapour, .	1·42	,,	1·03	,,
Carbonic Acid gas,	·08	,,	·10	,,

Air usually contains a minute quantity of carburetted hydrogen, and under certain conditions yields traces of Ozone, Ammonia, and Nitric acid. The quantities of the two latter are much diminished by rain.

The atmosphere of crowded and imperfectly ventilated rooms contains a large excess of CO_2; and that of large towns is also contaminated with Sulphurous acid (SO_2), Sulphuretted hydrogen (H_2S), and animal effluvia.

Chemical analysis has, however, proved that the various substances which may be mixed with the atmosphere quickly disappear, and that its composition is everywhere nearly uniform. Professor Graham has ascertained that each gas has a diffusive power peculiar to itself, which is inversely proportional to the square root of its density, and by which it tends to mix with other gases.

The properties of Atmospheric air are the mean of those of its constituents, and its chemical actions are due to the oxygen; by this it is enabled to support combustion and respiration, the oxygen removed in these processes being converted into an equal volume of carbonic acid. Fishes depend upon its presence in the water, though this dissolves only a small portion of air, but more of its oxygen than of its nitrogen. The processes of vegetation are also dependent upon the atmosphere, as it conveys water and carbonic acid to the leaves of plants, where the carbon becomes fixed, and the oxygen again set free; and thus plants contribute to purify the air which has been deteriorated by respiration and combustion. As the atmosphere varies in the quantity of moisture it contains, so it assists in the distribution of water over the surface of the globe, and is, by its mobility, the principal agent by which the extremes of temperature are moderated. According to the temperature and moisture of the atmosphere, so is the rate of evaporation, and consequently of perspiration. Hence not only do many chemical operations require a knowledge of the constitution of the atmosphere, but the functions of the body are influenced by its varying conditions; and the action of some medicines are modified by its different degrees of density and of dryness.

OXYGEN: O=8 or **O**=16. Atomic vol. 1.

Vital Air. L. *Oxygenium.* F. *Oxygène.* G. *Sauerstoff*

Oxygen was discovered by Priestley in 1744, and so named by the French chemists from *ὀξὺς*, *acid*, and *γεννάω*, *to beget*, on account of its acidifying properties. It is the most extensively diffused body in nature, forming one-fifth by weight of the atmosphere, eight-ninths by weight of water, and probably not less than one-third of the solid crust of the globe; for silica, alumina, and carbonate of lime contain nearly one-half of their weight of oxygen. It is, moreover, an abundant constituent of organic bodies, forming about one-third of the weight of woody matter (cellulin), and nearly one-fourth of that of dried flesh.

Preparation.—Heat powdered and dried *black oxyde of manganese* in an iron gas bottle, till it is red hot; collect the gas. 1 lb. should yield about 7 gallons ($3MnO_2=M_3O_4+O_2$). Or the *red oxyde of mercury* or *nitre* may be heated to dull redness to obtain this gas. 100 grs. *chlorate of potash*, heated in a retort or tube, yield 100 c. i. of pure Oxygen:—($2KClO_3=2KCl+6O$).

Properties.—A permanent colourless gas, devoid of odour and of taste. It is somewhat heavier than common air, its sp. gr. being 1·1056. At a temperature of 60° and a barometrical pressure of 30 inches, 100 cubic inches weigh 34·203 grains: it is sixteen times heavier than hydrogen, and has never been liquified. 100 volumes of water, at a medium temperature, dissolve about 3·5 of the gas. Oxygen has most extensive affinities, combining with every elementary body, except fluorine. The bodies which are thus formed exhibit the properties of the three distinct classes of chemical bodies, known as *bases*, *neutral substances*, and *acids;* the degree of acidity being always proportionate to the quantity of oxygen present. Some of the bases are called oxydes, others alkalies; both combine with the acids to form salts. Some bodies combine slowly with oxygen, others with great vehemence, resulting in the evolution of light and heat, as in the combustion of bodies in the air, the brilliancy of which is much increased when taking place in oxygen gas. Respiration is a slow combustion; the oxygen of the air combines with the carbon of the blood, and is expelled as carbonic acid.

Tests.—A rough test of the purity of this gas is, introducing into it a *glowing* taper: if the gas be pure, the taper will immediately burst into a flame.

Action. Uses.—When animals are made to inspire pure oxygen, the pulse and breathing are at first accelerated; after an hour symptoms of coma begin to appear, and the animal dies of asphyxia in from six to twelve hours. The blood becoming surcharged with oxygen, the movement in the capillaries slowly diminishes until there is complete stagnation. The tissues themselves being *over*-oxygenated, no longer induce that flow of blood which arises from their *want* of oxygen. In impending asphyxia, from impeded respiration, oxygen diluted with twice its bulk of air, may be inhaled for half an hour at a time three or four times a day. Oxygen water is a moderate stimulant, and may be given to the extent of a bottle or two daily.

1. **Ozone** (*ὄζειν, to emit an odour*) is a more condensed and active form of oxygen. It is always formed by the passage of electricity through oxygen, and is therefore present in the air after the electrical discharges of a thunderstorm. The oxygen which escapes from the positive pole in the electrolysis of water is ozonised. By passing a silent stream of electricity through oxygen contained in sealed tubes, Andrews and Tait effected a contraction of the gas, equal to $\frac{1}{12}$th of its bulk.

Preparation.—Ozone is formed in the slow oxydation of such bodies as phosphorus, oil of turpentine, and æther. A dilute mixture with air may be readily prepared by placing a stick of clean but moist phosphorus in a bottle of air, at 60° or 70° temp., for not longer than two hours.

Properties.—A faint chlorinous odour, and an irritating action on the mucous membranes. It bleaches and converts blue indigo into yellow isatin; corrodes organic matters, rusts iron, and rapidly oxidises moist copper, silver, and mercury. It converts the protoxide of manganese into peroxide, and sulphide of lead (PbS) into sulphate ($PbSO_4$). It decomposes the iodides, setting iodine free. A temperature between 250° and 300° decomposes it slowly, and one of 572° instantaneously. Ozone is insoluble in water.

Tests.—Paper wetted with solution of manganous sulphate ($MnSO_4$), or stained black with plumbic sulphide (PbS), or moistened with starch, containing a trace of potassic iodide (KI)—1 part in 200 of the solution of starch. In the first case, the colourless paper will be turned brown; in the second, it will become colourless; in the third, blue. The moistened iodide and starch paper often becomes blue on exposure to the air; but this must not be taken as positive evidence of the existence of ozone in the air; because chlorine, the higher oxydes of nitrogen, and other bodies, liberate iodine from the iodide.

NITROGEN : $N=14$ or $\mathbf{N}=14$. Atomic vol. 1.

L. *Nitrogenium. Azote.* F. *Azote. Nitrogène.* G. *Stickstoff.*

Nitrogen was so called from being considered the producer of nitre or of nitrates. It was discovered in 1772 by Rutherford. Its properties may be considered the reverse of those of oxygen. One of its names, Azote (α, *privative*, and ζωή, *life*), indicates its inability to support life. It is abundantly diffused, as it forms four-fifths of the atmosphere. Its chief use seems to be, to dilute the oxygen, though it no doubt also performs some more important functions. It exists also in small quantity in the ammonia of the atmosphere, also in the nitric acid which is found in it after thunderstorms. It forms a constituent of all animal bodies, and likewise of many vegetable products which form the food of animals.

Preparation.—Nitrogen may be obtained—1. by burning *Phosphorus* carefully in a jar of common air, when the whole of the oxygen being abstracted, the nitrogen is left comparatively pure; or 2. by passing *air*, deprived of CO_2 and Aq, over fragments of ignited copper, contained in a tube of hard glass; and 3. by passing a stream of *chlorine* through solution of *ammonia* ($4NH_3+3Cl = 3NH_4Cl+N$). Care must be taken to keep the ammonia in excess, or else explosive chloride of nitrogen will be formed.

Properties.—Nitrogen is colourless, tasteless, inodorous; nor can it support either combustion or respiration. 100 vols. of water at 60° dissolve only $1\frac{1}{2}$ vol. of nitrogen. It is lighter than air; sp. gr. ·972; 100 cubic inches weigh 30·119 grains. It has never been liquefied. It forms, however, numerous compounds with other elements, many of which are possessed of very active properties, *e.g.*, nitric acid, ammonia, quinia, aconitia, hydrocyanic acid. Its chemical activity is not easily excited, but under certain circumstances it will unite directly with H, O and C, and with Titanium, and some other metals. In combination its affinity is weak, and hence its compounds are extremely prone to decomposition, which in the case of some of the mineral ones, occurs with explosive violence.

Action. Uses.—Excepting as a diluent of oxygen, we know nothing of either. Azotised substances are the most nourishing as food.

HYDROGEN: H=1 or H=1. Comb. vol. 1.

L. *Hydrogenium.* F. *Hydrogène.* G. *Wasserstoff.*

Hydrogen, from ὕδωρ, *water*, and γεννάω, *to beget*, does not exist free in nature, but combined is a constituent of water, of some acids, gases, and all organic matter. It was discovered in 1766 by Cavendish. It is chiefly interesting as a constituent of water, of hydrocarbons, of hydrochloric and hydrocyanic acids, also of all organic substances.

Preparation.—1. From steam, by passing it over iron filings heated to redness in an iron tube. The O of the water is removed by the iron forming magnetic oxyde, and the liberated H passes onwards, and may be collected ($3Fe+4H_2O=FeO,Fe_2O_3+8H$). 2. By the action of zinc on dilute sulphuric acid ($H_2SO_4+Zn=ZnSO_4+2H$).

Properties.—An invisible gas, devoid of odour or taste; 14·4 times lighter than air; its sp. gr. ·0692. 100 c. i. weigh 2·14 grains. 100 vols. of water dissolve 2 vols. of hydrogen. It is inflammable, burning with a pale yellowish flame, and uniting with the oxygen of the air to form water. These gases, when mixed, do not unite until they are inflamed. Hydrogen, being the lightest body known, is taken as the standard both for atomic weights and combining volume; its atomic weight therefore is 1, and its combining volume 1.

WATER: $HO=9$ or $H_2O=18$. Atom. vol. of Vapour, 2.

Aqua. Aqua Destillata. Distilled Water. F. *Eau.* G. *Wasser.*

Unlike Air, Water is a chemical compound: one atom of Oxygen is combined with two of Hydrogen; which combination, therefore, or some multiple of it, is added to the equivalent number of chemical compounds when water is in combination.

Preparation.—Pure water is obtained by distillation, the worm of the still being made of pewter or copper. A little lime should be added to the water in the still, to retain carbonic and hydrochloric acids, and the first gallon of distillate should be rejected.

Characters and Tests.—Water is colourless, and devoid of both taste and smell. A fluid ounce leaves no trace of solid matter on evaporation, neither sulphuretted hydrogen, oxalate of ammonia, nitrate of silver, chloride of barium, nor solution of lime producing change, proving the absence of metals, lime, chlorides, sulphates, and carbonates, or carbonic acid respectively. Distilled water contains from 1·5 to 2 per cent. by volume of air, the oxygen and nitrogen always being in the proportion of one measure of oxygen to two of nitrogen.

Water is the standard of comparison for specific gravities. Its sp. gr. is therefore represented by 1 or 1000, according to convenience; a cubic inch at 62° Fahr. weighs in air 252·456 grains, and a cubic foot 997 ounces. Water freezes at 32°, but attains its greatest density at 40°, expanding at a lower temperature; therefore ice (sp. gr. 0·918) readily floats upon water. In the solid state water assumes a variety of crystalline forms, which are derived from the rhombohedron and six-sided prism. It boils at 212°, and is then converted into steam, of which the sp. gr. is ·622 at 212°, when it has the greatest density, and is composed of one volume of oxygen combined with two volumes of hydrogen condensed into two volumes. Water furnishes a larger quantity of vapour than any other fluid, a cubic inch expanding to 1696 cubic inches or nearly a cubic foot of steam, and in the production of the latter 1000 degrees of heat become latent, the sensible heat of steam not exceeding that of boiling water. But water passes at all temperatures into the air by spontaneous evaporation, and causes its greater or less moisture or dryness. It forms a large proportion of most organised bodies, and dissolves a great variety of solid substances, and usually in increased proportion as its temperature is increased. It likewise dissolves many of the gases—some, as air, oxygen, and carbonic acid, in small proportion; but others, as ammoniacal and hydrochloric acid gases, in immense quantities.

Some bodies absorb large quantities of aqueous vapour, and are therefore called *hygroscopic*, such are sulphuric acid, glycerine, caustic potash, soda, lime, and calcic chloride; the latter, too, absorb sufficient to effect their solution, and are therefore called *deliquescent.* Crystalline salts usually contain a definite quantity of water, which is essential to the form of the salt, but which may be dissipated on the application of heat. This is called *water of Crystallisation.* Some salts, in like manner, crumble down to a powder, from loss of their water of crystallisation, on mere exposure to dry air. The sulphates of soda and zinc furnish examples of this *efflorescence.* Water enters into chemical combination with various bodies, which are then called *Hydrates* (from ὕδωρ, *water*); thus, when metallic oxydes are precipitated in aqueous solutions, they are usually in the hydrated form; the caustic alkalies and caustic lime, baryta, &c., are hydrates; carbonic, sulphuric, nitric, phosphoric, and boracic anhydrates are destitute of acid properties until they are combined with water, the hydrogen of which forms a weak base to the acid salt thus formed. Water is also decomposed in a variety of reactions, furnishing oxygen to oxydisable substances (*e.g.*, potassium, charcoal, or iron heated to redness—(see p. 37), and hydrogen to the halogens.

Water is so universal a solvent, that it is apt to contain many impurities (see Varieties of Water below). As an example of the amount of impurity in the different kinds of water supplied to the inhabitants of towns, we may quote a report of the late Dr Dundas Thomson. In the water of a well in the parish of St Marylebone, London, he found 17½ grains of organic impurity, and 87 grains of inorganic impurity in the gallon; total, 104½ grains. In the water of the river Thames, 3⅓ organic, and 16½ inorganic matter; total, about 20 grains. In the water of Loch Katrine, supplied to the inhabitants of Glasgow, there was about ¾ grain of organic, 1½ inorganic; total impurity, 2¼ grains in the gallon. The action of water on lead in cisterns and pipes is considered under the article LEAD.

Action and Uses.—Water, forming as it does so large a portion of the blood, is a chief means for increasing its fluidity, facilitating circulation, diluting secretions, and rendering them less irritant. As a Therapeutical agent, water plays an important part, as it is often the best medium for applying either heat or cold to the body. It is also a necessary constituent of the aliment of all living beings, acting generally as a solvent. It will act also as a solvent of many solid substances, as it passes through the system, and forms the principal part of Diluent and Demulcent remedies.

From its great solvent powers it is an important agency in Pharmacy, forming the various aqueous Solutions, Medicated Waters, Infusions, Decoctions, and it is employed to dilute Acids, Alkalies, and Spirit. It is useful also in some decompositions, its Oxygen serving to oxydise different bodies, and its Hydrogen escaping. *Whenever "water" is directed to be used, "distilled water" is invariably implied.*

The following varieties of water require consideration:—

1. **Rain Water,** after several days of continuous rain, and in the absence of electrical discharges, is nearly pure, excepting saturation with air ($2\frac{1}{2}$ volumes in 100 of water); but the first rain after a season of drought, and especially in thundery weather, contains traces of nitrates (see p. 69), salts of ammonia (see p. 69), and ammonia organic impurities.

2. **Well Water,** in towns, and in the vicinity of cesspools, graveyards, stables, cow-sheds, and the like, is often dangerously impure from the presence of organic matters (sometimes fæcal and urinary constituents). By the slow oxydisation of these, large quantities of nitrates (see p. 69) are ultimately formed in these waters, giving them a sweet attractive taste. Well water derived from the surface is always rich in organic matters and nitrates; that obtained from deep Artesian wells is impregnated with the soluble salts of the strata in which the water is collected. Thus the springs in the chalk contain from 18 to 20 grains of chalk in a gallon, as well as a little carbonate of soda. If it should become,—

3. **River Water,** some of the free Carbonic acid escapes, and nearly one-third of the chalk is deposited. Iron is separated in the same way, so that, as a rule, running streams contain less mineral matter than springs; their water is not so "hard,"—that is to say, it forms a lather with soap more readily. By boiling, these waters are rendered much purer and "softer."

4. **Sea Water.**—According to Schweitzer, an imperial pint of the water of the English Channel contains 240 grains of chloride of Sodium, $6\frac{1}{2}$ grains of chloride of Potassium, $26\frac{3}{4}$ grains of chloride of Magnesium, $\frac{1}{4}$ grain bromide of Magnesium, 20 grains of sulphate of Magnesia, 12 grains of sulphate of Lime, $\frac{1}{4}$ of a grain of carbonate of Lime, and trace of Iodine and Ammonia. The sp. gr. is about 1·027, the solids being about 3·5 per cent.

5. **Mineral Waters.**—These, the medicines furnished by nature ready for our use, may very appropriately have the foremost place assigned to them in the Materia Medica. The medicinal properties of the various natural waters will be inferred from the following classification and particulars:—

i. *Alkaline Waters.*—Carbonic acid and Bicarbonate of soda being the essential constituents. The quantities of the latter or of carbonate are those contained in an imperial pint:

1. Apollinaris, 70°, sparkling, and about 12 grs. of Carbonate of soda.
2. Bilin, 53°, still, containing less than its bulk of free CO_2, and about 28 grs. of Carbonate of soda.
3. Fachingen, 50°, sparkling, 35 grs. of Bicarbonate of soda.
4. Fellathal, sparkling, about 32 grs. of Carbonate of soda.
5. Geilnau, 50°, slightly sparkling, containing rather more than its bulk of free CO_2, and 10 grs. of Bicarbonate of soda.

6. Giesshübel, 48·5°, sparkling, about 9 grs. of Carbonate of soda.
7. Ilkeston and Malvern, still, and about ½ gr. of Carbonate of soda.
8. Mariensprudel, sparkling, about 7 grs. of Carbonate of soda.
9. Nauheim, still, about 5 grs. of Carbonate of soda.
10. Obersalzbrunn. Here are two springs used for drinking—Oberbrunnen and Mühlbrunnen. Both are sparkling; contain about 10 grs. of Carbonate of soda, and rather more than 1½ gr. of Chloride of sodium.
11. Preblau, sparkling, about 26 grs. of Carbonate of soda.
12. Victoriaquelle, still, 12·5 grs. of Bicarbonates of soda.
13. Vichy. Here there are nine springs. The Puits carré, Puits Chomel, Grande Grille, have temperatures varying from 110°·5 to 105°. Source de l'Hôpital, 89°. Source Lucas, 83°·3. Source du Parc, 71°·6; Source des Dames, 62°·6; Source d'Hauterive, 59°. And Source des Célestins, 53·6. They are all still, containing less than half their bulk of CO_2, and very nearly the same quantity of Bicarbonate of soda, viz., about 48 grains.

All the foreign waters in this list contain minute quantities of iron in the form of Carbonate of the protoxide; those of Giesshübel and Vichy the least, from 0·0004 to 0·03 of a grain in a pint; and those of Fachingen (0·1 gr.), Apollinaris (0·15 gr.), and Geilnau (0·3 gr.), the most.

All contain a little chloride of sodium, from 0·7 to 5 grs. in an imperial pint; Vichy containing the latter quantity. Vichy waters contain a trace (0·01 gr. in imp. pint) of Arseniate of soda.

ii. *Akaline Salt Waters.*—These only differ from the preceding in containing a larger quantity of Chloride of sodium, and Vichy water is the connecting link between the two classes.

1. Ems. The waters of the numerous springs agree closely in composition; they are all still, containing about half their bulk of CO_2, about 18 grs. of Bicarbonate of soda, and 9 of Chloride of sodium in the imperial pint. They are all thermal, the temperature of the principal being as follows:—Krähnchen, 85°; Fürstenbrunnen, 95°·4; Kesselbrunnen, 115°; and Neue Quelle, 117°·5.
2. Luhatschowitz. Here are four springs—Vincenzbrunnen, 47°·5, and Amandibrunnen, 45°·5; both are sparkling, but the former contains thrice its bulk of free CO_2. The other two springs—Johannbrunnen, 45°·5, and Louisenquelle, 48°·6, and also the water used for bathing—are still. They all contain from 30 to 50 grs. of Carbonate of soda, and from 25 to 40 grs. of Chloride of sodium in the imperial pint, and small portions of Bromide and Iodide (see Class V.).
3. Gleichenberg. Here are two springs:—Constantinsquelle, 61°, and Johannisbrunnen, 56°·75. Both are sparkling. The

former contains 24 grs. of Carbonate of soda and 18 grs. of Chloride of sodium in the imperial pint, and the latter 16 of the former and about 5 of the latter.

Krankenheil, } See below, Class v.
Lippik, }

4. Roisdorf. Both the Trinkquelle and Stahlquelle are feebly effervescent; the former contains about 8 grs. of Carbonate of soda and 18 grs. of Chloride of sodium in an imperial pint, and the latter 2 of the former and about 5 of the latter.
5. Selters. Sparkling; contains 12 grs. of Bicarbonate of soda, 20 of Chloride of sodium, $\frac{1}{10}$ of a gr. of Bicarbonate of Iron, and a minute trace of Bromide, in the imperial pint.
6. Sinzig. Still; contains the same proportion of Bicarbonate and Chloride as Selters, but is free from both Iron and Bromine.
7. Weilbach. 54°·5, still; contains 9 grs. of Carbonate of soda and 12 grs. of Chloride Sodium in the imperial pint.

All these waters, excepting the Constantinsquelle of Gleichenberg and the spring at Sinzig, contain a minute quantity (from 0·019 to 0·020 gr. in a pint) of Bicarbonate of Iron; Ems and Selters contain traces of Manganese; Ems and Luhatschowitz, traces of Baryta and Strontia; Luhatschowitz and Weilbach have traces of Lithia; and minute quantities of Iodine and Bromine.

iii. *Alkaline Saline Waters.*—Sulphate and Carbonate of soda are the chief constituents of these.

1. Bertrich. 90°·5, slightly sparkling; contains about 9 grs. of Sulphate and 2 grs. of Carbonates of soda and 4 grains of Chloride of sodium in an imperial pint.
2. Carlsbad. All the springs are thermal, varying from 105° to 162°, still, or only slightly sparkling, and contain from 18 to 24 grs. of Sulphate of soda, from 9 to 12 grs. of Carbonate, and a little less than this quantity of Chloride of sodium.

   The Marktbrunnen differs from the rest in containing traces of Iodine and Bromine.
3. Ofen. 140°, still; contains only 13 grs. of solids in the imperial pint, of which nearly 4 are Sulphate of soda and 3 Carbonate, with traces of Sulphuretted Hydrogen.
4. Rohitsch. 48° to 52°, still, or nearly so; contains about 20 grs. of Sulphate of soda, 6 of Carbonate, 14 of Carbonate of lime, and 12 of Carbonate of magnesia in an imperial pint.
5. Scuols and Tarasp. The waters of the Grosse and Kleine Quelles have the same composition. They are both cold, 37°, slightly sparkling, and contain 21 grs. of Sulphate of soda, 35 of Carbonate of soda, 36 of Chloride of sodium, 15 of Carbonate of lime, 7 of Carbonate of magnesia, nearly 4 of Sulphate of potash, and about 1·9 grs. of Iodide of sodium.
6. Marienbad. Of the 130 cold springs in this neighbourhood,

the *Kreuzbrunnen* and *Ferdinandsbrunnen* are most esteemed. They are both slightly sparkling, and contain about 45 grs. of Sulphate of soda, 15 of Bicarbonate, 14 of Chloride sodium, and 7 each of Bicarbonate of lime and magnesia, and traces of Bromides. The Waldquelle, Wiesenquelle, and the Marienquelle, agree with the former in the nature and proportion of their constituents, but contain, the two former only $\frac{1}{4}$ of the quantity of solid matter, and the latter but $\frac{1}{30}$. The Marienquelle, however, is rich in CO_2. It is chiefly used for bathing.

iv. *Simple Salt Waters.*—Chlorides prevail in these, Chloride of sodium being by far the most essential constituent.

1. Baden-Baden. The *Hauptquelle*, 155°·7, is still, and contains 20 grs. of NaCl, and about 1½ gr. each of Bicarbonate of lime and Chloride of potassium in imperial pint.

   The *Murquelle* and *Fettquelle* have the same amount of Chloride of sodium and potassium, but have in addition Chloride of Lithium, the former as much as 2·5 grs. in the imperial pint, and the latter $\frac{1}{10}$ of this amount.
2. Bourbonne-les-Bains (Fontaine Chaude). 149°; contains 56 grs. of NaCl, 7 grs. Chloride potassium, 3 grs. of Carbonate of lime, and 7 of Sulphate of lime in an imperial pint.
3. Cheltenham forms a natural link between this class and the previous one, agreeing in composition with the waters of the Engadine. The Pitville water is still, and contains 60 grs. of NaCl, 15 grs. of Sulphate of Soda, and 3 grs. of Carbonate of soda in an imperial pint, and traces of Sulphuretted Hydrogen.
4. Homburg.' About 50°, all very sparkling. The *Kaiserbrunnen* contains 130 grs. NaCl, 10 grs. of Chloride of magnesium, and 20 grs. of Chloride of calcium in an imperial pint. The *Elizabethbrunnen*, $\frac{1}{3}$ less NaCl, the same amount of Chloride of magnesium, but differs in the large amount (nearly 14 grs.) of Carbonate of lime. The Stahlbrunnen also contains much Lime (12 grs. of Chloride and 9 of Carbonate), but otherwise closely agrees with the Elizabethbrunnen. The Ludwigsbrunnen agrees with the Stalbrunnen in the nature and proportion of its constituents, but the solid constituents of the latter (138 grs. in imp. pint) exceed those (83 grs.) of the former.
5. Kissengen. 51°, still. The three springs, *Ragoczi*, *Pandur*, and *Maxbrunnen* agree in the nature and the proportion of their constituents; but the latter contains less than half the amount (35 grs. in an imp. pint) of solid matters contained in the former two, and is free from Sulphate of magnesia. The former two contain about 54 grs. of NaCl, 3 grs. each of Chloride of potassium and magnesium, and nearly 6 grs. of

Sulphate of magnesia in the imperial pint; they may therefore be classed with the "Bitter Waters."

6. Kronthall. 56° to 61°, very sparkling. They contain only about 40 grs. of solid matters in the imperial pint, and these are almost wholly composed of NaCl (34 grs.) and Carbonate of lime (5 grs.).
7. Meinberg. The Trinkbrunnen contains 50 grs. of NaCl, about 7 of Chloride of magnesium, 13 of Sulphate of soda, 15 of Sulphate of lime, and about half as much Carbonate in an imperial pint.
8. Mondorf. 77°; contains only a very small quantity of CO_2, but 80 grs. of NaCl, 30 of Chloride of calcium, and 15 of Sulphate of lime in an imperial pint.
9. Soden. Cold, and sparkling. The Wilhelmsbrunnen and Soolbrunnen contain about 135 grs. of NaCl, 4 grs. Chloride potassium, and 10 of Carbonate of lime in an imperial pint. The Milchbrunnen and Warmbrunnen have the same constituents, and in about the same proportion, but contain less than $\frac{1}{4}$ the amount of solid matters.
10. Wiesbaden. Here are twenty-three hot springs, the chief being the Kochbrunnen, 155°·75, still, and contains about 70 grs. NaCl, and 4 grs. each of Chloride of calcium and Carbonate of lime, with a trace (0·001 gr.) of Arseniate of lime.

V. *Salt Waters, containing Iodine and Bromine, or both.*

1. Adelheidsquelle contains 56 grs. of solids in the imperial pint, 47·5 of which is NaCl, 0·46 Bromide of sodium, and 0·27 Iodide of sodium.
2. Castrocaro is a strong brine, containing 500 grs. of NaCl in an imperial pint, the remainder of the solids being composed of 26 grs. of Sulphate of soda, 7 grs. of Carbonate of lime, $3\frac{1}{2}$ of Carbonate of magnesia, $1\frac{1}{2}$ gr. of Iodide of sodium, and $\frac{1}{10}$ gr. of Bromide of sodium. It requires considerable dilution for internal use.
3. Durkheim. The springs here (Virgiliusbrunnen and Bleichbrunnen) contain about 120 grs. of solids in the imperial pint, which is chiefly NaCl, about 20 grs. being Chlorides of calcium and magnesium, 0·241 grs. Bromide of sodium, and 0·023 gr. Iodide of sodium.
4. Elmen. The drinking water here is a strong brine, an imperial pint containing 280 grs. of solids, of which 250 are NaCl, and 1·8 Bromide of magnesium. The water used for bathing contains $\frac{1}{3}$ more NaCl, and more than twice as much Bromide of magnesium.
5. Lippik. About 120°, evolving Carbonic acid and much Nitrogen. An imperial pint contains only 28 grs. of solids, of which 12·5 are Carbonate of soda, 6 grs. each of Sulphate of soda and Chloride of sodium, and 0·38 of Iodide of calcium.

6. Krankenheil. 47°, still. These are very weak alkaline waters, an imperial pint containing not more than 8 grs. of solids, composed chiefly and pretty equally of Bicarbonate of soda and Chloride of sodium. The Iodide of sodium is a mere trace, viz., the 0·015 of a grain.
7. Kreuznach. Of the four cold (54°·5) springs here, the Elisenquelle is the only one used for drinking. It is a strong salt water, containing in an imperial pint 90 grs. of NaCl, 16 of Chloride of calcium, 5 of Chloride of magnesium, 0·34 gr. Bromide of magnesium, and 0·045 grs. Iodide of magnesium.

   The *Orianienquelle* has the same constituents, and in the same proportions; but it is almost twice as rich in them, the water being a strong brine.
8. Wildegg. The water here contains in an imperial pint 130 grs. of solids, of which 94 are NaCl, 15 Chloride of magnesium, 0·39 Iodide of sodium, and 0·008 Bromide of sodium.
9. Zaizon. The waters here are also alkaline and sparkling. The total amount of solids in an imperial pint is—26 grs. in the Ferdinandsbrunnen, and 8 in the Franzensbrunnen; nearly half of this is Carbonate of soda, and according to Greissing and Schnell, there are 2·4 grs. (!) of Iodide of sodium in the former, and 0·08 gr. in the latter.

Some other waters contain traces of Iodides or Bromides. This is the case with the springs at Scouls and Tarasp (Class iii. 5), the Kreuzbrunnen, and Ferdinandsbrunnen, at Marienbad (iii. 6), the springs at Luhatschowitz (ii. 2), that of Marktbrunnen, at Carlsbad (iii. 2), and the spring at Purton (vii. 8).

vi. *Brines.*—These contain from 125 to 2000 grs. of Chloride of sodium in the imperial pint, and are for the most part only used for bathing.

1. Achselmannstein.
2. Arnstadt.

These brines are almost as strong as that of Jaxtfeld, an imperial pint containing more than 2000 grs. of salts, nearly wholly composed of NaCl.

3. Hall. (Both in the Tyrol and in Würtemberg are brine springs.)
4. Hubertusbrunnen, in the Hartz mountains, contains 130 grs. NaCl, and 100 grs. of Chloride of calcium in an imperial pint.
5. Ischl contains about 275 grs. NaCl in an imperial pint.
6. Jaxtfeld contains 2400 grs. of Chloride of sodium in an imperial pint.
7. Nauheim. The Kleiner Sprudel, 74°·6; the Grosser Sprudel, 100°. From 200 to 300 grs. NaCl.
8. Rehme. The thermal spring about 325 grs. of NaCl; the cold spring about 130 grs. and 20 of Sulphate of soda.

9. Wittekind contains 300 grs. NaCl, and about 9 grs. of the Chloride of magnesium and calcium in the imperial pint.

vii. *Magnesia* or *Bitter Waters.*—The Sulphates of soda and magnesia are the essential constituents of these.

1. Cherry Rock, in Gloucestershire. A little free CO_2. Contains in the imperial pint 56 grs. of solids, of which 16 are Sulphate of magnesia, 15 Sulphate of soda, 7 Chloride of sodium, 9 Sulphate of lime, 3 nitrogenised organic matter, and traces of Iodine and Bromine.
2. Friedrichshall. A little free CO_2, and about 240 grs. of solids in the imperial pint; of which 55 are Sulphate of soda, 48 Sulphate of magnesia, 80 Chloride of sodium, 38 Chloride of magnesium, 13 Sulphate of lime, and 4½ Carbonate of magnesia.
3. Gran. These waters are very powerful, containing from 400 to 800 grs. of Sulphate of magnesia in the imperial pint.
4. Ivanda. This water does not contain Sulphate of magnesia, but sufficient Chloride to give it a title to "bitter water." It contains 200 grs. of solids in an imperial pint, of which 146 are Sulphate of soda, 32 Sulphate of lime, 2·8 Carbonate of lime, 17 Chloride of magnesium, and 3·5 Nitrate of magnesia.
5. Kissengen. The bitter water here contains a little free CO_2, and in an imperial pint 56 grs. of Sulphate of soda, 48 of Sulphate of magnesia, 36 Chloride of magnesium, 75 of Chloride of sodium, and about $\frac{1}{10}$ gr. of Chloride of lithium.
6. Leamington. The old well contains a trace of CO_2 and 130 grs. of solids in an imperial pint, composed of 58 grs. each of Chloride of sodium and Sulphate of soda, 29 grs. of Chloride of calcium, and about 4 of Chloride of magnesium.
7. Püllna contains in the imperial pint 310 grs. of solids, of which 154 are Sulphate of soda, 5½ Sulphate of potash, 117 Sulphate of magnesia, 20 Chloride of magnesia, 8 Carbonate of magnesia, and 3 Sulphate of lime.
8. Purton, near Swindon, contains a little CO_2, a trace of Sulphuretted Hydrogen; and in an imperial pint 43½ grs. of solids, of which 14 are Sulphate of soda, 9½ Sulphate of magnesia, 10 Sulphate of lime, 3½ Carbonate of potash, and 4¼ Chloride of sodium, 0·008 gr. of Iodide of sodium, and 0·011 gr. of Bromide of magnesium.
9. Saidschutz. This water contains in an imperial pint 223 grs. of solids, composed mainly of 105 grs. of Sulphate of Magnesta, 58 of Sulphate of soda, 31 of Nitrate of magnesia, 6 of Carbonate of magnesia, 12½ of Sulphate of lime, and 5 of Sulphate of potash.
10. Sedlitz. Of the 140 grs. of solids contained in an imperial pint of this water, 93 grs. are Sulphate of magnesia, 21 Sulphate of soda, 6½ Carbonate of lime, 5 Sulphate of lime, and 5 Sulphate of potash.

viii. *Chalybeate Waters:—*

1. Altwasser, 70°.
2. Brückenau, 49°·5.
3. Cambray, 51°.
4. Driburg, 51°.
5. Imnau, 51°.
6. Pyrmont, 54°·5.
7. Schwalbach, 49°·5.
8. Spa, 52°.
9. St Moritz, 42°.

These are almost all sparkling alkaline waters, a few only containing less than their bulk of CO_2. The iron exists in the form of Bicarbonate of the protoxide, and varies in quantity from 0·3 gr. to 1 gr. in the imperial pint. The quantity of solid matters reaches 50 grs. in the *Trinkquelle* of Driburg. The waters of Altwaser contain from 4 to 8 grs.; the *Stahlquelle* of Bruckenau, 4¼ grs.; those of Cambray, 5½ grs.; those of Imnau, 14¼ grs.; those of Pyrmont, 35 grs. (one-half being composed of Bicarbonate and Sulphate of lime). The *Weinbrunnen* of Schwalbach has 15 grs. of solids, more than half being Bicarbonates of lime and magnesia and 2¼ Bicarbonate of soda. The *Stahlbrunnen* contains only 5½ grs. of solids. The water commonly drunk at Spa, the *Pouhon*, contains about 5 grs. of solids, differing very little from the waters of Schwalbach. The St Moritz waters contain less iron than the Schwalbach.

10. Bocklet.
11. Borszék, 48°·5.
12. Cheltenham.
13. Cudowa, 52°.
14. Elster, 50°.
15. Franzensbad, 51°.
16. Harrowgate.
17. Petersthal, 48°.
18. Recoaro.
19. Reinerz, 54°–62°.
20. Rippoldsau, 48°.
21. Tunbridge Wells.

These are cold, alkaline, saline, and, excepting No. 16, sparkling. The iron exists in the same state as in the former variety, and in about the same quantities. The salts are Chlorides of sodium and magnesium, Carbonate and Sulphate of soda, and Sulphate of magnesia. The free CO_2 also holds Carbonate of lime and magnesia in solution in these. In the Franzensbad waters Sulphate of soda (from 20 to 30 grs. in the pint) prevails; in the Cudowa, Bicarbonate and Sulphate of soda; in those of Bocklet, Chlorides of sodium and magnesium; in those of Petersthal, Bicarbonates of lime (13 grs.) and magnesia (4½ grs.). In the Montpellier spring at Harrowgate, there is more than double the quantity of saline matter (113 grs.) than in any of those here mentioned, and of this 82 grs. are NaCl, and 19 Chloride of Calcium.

ix. *Sulphur Waters:—*

1. Aix-la-Bains, 108° to 116°.
2. Aix-la-Chapelle, 116° to 131°.
3. Baden (Vienna), 89° to 95°.
4. Baden (Switzerland), 117° to 122°.
5. Bagnères de Luchon, 133°.
6. Barèges, 87° to 113°.
7. Borcette, 171°.
8. Cauterets, 118°.
9. Eaux-Bonnes, 91°.
10. Eaux-Chaudes, 93°.
11. Eilsen, 59°.
12. Harrowgate, 50°.
13. Mehadia, 116° to 133°.
14. Meinberg, 61°.
15. Nenndorf, 50°.
16. Saint Sauveur, 94°.
17. Weilbach, 54°.

These waters have the odour of Sulphuretted hydrogen, and it is due to the presence of minute portions of *Sulphide of sodium*, and sometimes *free Sulphuretted hydrogen*. In the waters of Harrowgate (old well), 1·8 gr. Na_2S, and 0·72 cub. inch H_2S in imperial pint; Montpellier, 1·7 gr. Na_2S; Barèges, 1·7 gr.; Aix-la-Chapelle, 0·091 gr. to 0·022; the Kaiserquelle evolves a little HS; Bagnères du Luchon, 0·13 gr. Na_2S; Meinberg, 0·083 gr. Na_2S and 2·66 cub. in. H_2S; Borcette, 0·0063 Na_2S. The waters of Baden, in Vienna, contain the unoxydised sulphur, as *Sulphide of magnesium and* H_2S; the former constituent varies from 0·15 gr. to 0·147 gr., and the latter from 0·102 c.i. to 0·84 c. i. in an imperial pint. In the waters of Nenndorf the sulphur exists as *Sulphide of calcium and* H_2S, in the proportion of 0·69 gr. of the former and 1·5 c. i. of the latter to the imperial pint. The following waters are free from sulphides, the unoxydised sulphur existing as *Sulphuretted hydrogen only:*—Eilsen, from 1·96 c. i. to 2·62 c. i. in the imperial pint; Mehadia, Kaiserquelle, Ferdinandsquelle, 1·1 c. i., Ludwigsquelle, 0·6 c. i., and Karlsbrun, only a trace; Baden (Switzerland), a trace; Aix-les-Bains, 0·55 c. i.; Weilbach, 0·208 c. i. The waters of Aix-la-Chapelle, Borcette, and Weilbach are alkaline and salt, and the former two evolve abundance of CO_2, and contain not more than 42 grs. of solids. Those of Aix-la-Bains, Eilsen, Meinberg, and Nenndorf are chiefly sulphates. The waters of Aix-la-Bains contain only 4 grs. of solids in the imperial pint. The Harrowgate waters contain more than three times the amount of solids (chiefly chlorides, see Class vii.) contained in any other of these waters.

x. *Earthy Waters.*—These contain from 12 to 35 grs. of solids in the imperial pint. Sulphate of lime is the chief constituents of the waters of Bath (114°), Lucca (116°), and Leuk (123°); Bicarbonate of lime and magnesia those of the waters of Wildungen (sparkling); Carbonate of lime those of Pisa, Clifton (74°), and Buxton (82°).

xi. *Silicious Waters.*—All the foregoing waters contain from the $\frac{1}{100}$ of a grain to 1·2 grains of Silica in the imperial pint; the waters of Chaudes Aigues, Luxueil, and Mariara contain larger quantities. The geysers of Iceland contain 10·7 grs. of solids in the pint, and of these 5·4 grs. is Silica. It is chiefly combined in all with soda or lime.

xii. *Arsenical Waters.*—A minute quantity of *Arseniate of lime* is contained in the Kochbrunnen at Wiesbaden (Class iv. 10). A trace of *Arseniate of iron* in the Hauptquelle of Baden-Baden (Class iv. 1), and a trace of *Arseniate of soda* in Vichy waters (see Class i. 13).

SULPHUR: S 16 or **S**=32. Comb. vol. $\frac{1}{3}$; above 1904°·1.

L. *Sulphur. Brimstone.* F. *Soufre.* G. *Schwefel.*

Sulphur (from *sal*, salt, and *πῦρ*, *fire*, was employed in medicine by the Greeks, Arabs, and Hindoos. It occurs in many animal substances, as Bile, Albumin of egg, in some plants, as in the Brassicaceæ, Umbelliferæ, and in Garlic; and in the mineral kingdom, in gases, salts, and in mineral waters. In combination with metals, it forms the abundant ores called Pyrites—the Sulphides of iron, of zinc, copper, lead, mercury, &c., whence it is obtained by roasting, a part of the sulphur being burnt into Sulphurous acid, and another part is volatilised without change, and collected in chambers. Native or uncombined sulphur occurs in beds of blue clay in volcanic districts; that of commerce is brought chiefly from Italy, Sicily, and the adjacent islands. In 1853 nearly 1000 cwts. of rough sulphur were imported. Native sulphur is purified by distillation from earthen pots A, A, arranged in two rows in a large furnace. The sulphur

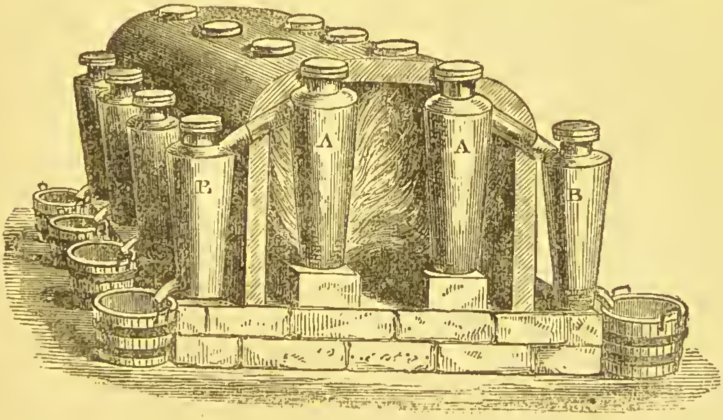


Fig. 21.

fuses and sublimes, and passes through a lateral tube (about 2 × 14 inches) in each pot, into another, B, placed on the outside of the furnace, which is perforated near the bottom, to allow the melted Sulphur to flow into a pail containing water, where it congeals and forms *rough* or *crude* sulphur. This being redistilled, fused, and cast into moulds, forms *stick* or *roll* sulphur.

Properties.—This elementary body is an opaque, shining, brittle solid, having a crystalline fracture. When pure it is pale yellow; but it may vary from lemon-yellow, through green, dark yellow, and brown-yellow, according to the degree of heat to which it has been subjected. Taste insipid; it acquires a faint and peculiar smell when rubbed; grasped in the hand it crackles from unequal expansion. Sulphur is an allotropic body, existing as it does in the crystalline, vitreous, and amorphous states. 1. The crystals are dimorphous. In the native state sulphur occurs in the form of rhombic octohedra (prismatic system); and it separates in this form from its solution in chloride of sulphur and carbonic disulphide. But if it be melted and allowed to crust, and then, by means of an aperture made in the crust by a hot wire, the central fluid portion be poured off, the cavity will be found lined with oblique prismatic needles (oblique system). This latter form, however, is not permanent, but soon breaks up into the first form, and the conversion is attended by the evolution of as much heat as would raise an equal bulk of water 4°. *Octohedral sulphur* is semitransparent, of a primrose-yellow colour, has the sp. gr. 2·05, and melts at 239°. *Prismatic sulphur* is of an amber colour, has the sp. gr. 1·98—that of roll sulphur—and melts at 248°. 2. The vitreous variety. The effect of heat on sulphur is remarkable. It begins to melt at 240°, and between 248° and 284° it forms a clear, moderately limpid, and yellow fluid; heat being continued, it becomes brown and opaque, and at 356° heat becomes latent, and the sulphur rapidly assumes a viscid condition. Heat being continued, the temperature after a time again rises, and at about 500° the sulphur again liquefies, and if it be now poured slowly into cold water, a soft amber or brownish mass results—*vitreous sulphur*—which may be drawn out into threads The sp. gr. of the variety is only 1·957. In a few hours this ductile sulphur begins to part with the latent heat it had absorbed, and is converted into a yellow brittle mass, composed chiefly of the octohedral form. Heated to 212° the change is effected suddenly with a rise of 28° of heat. 3. The amorphous form of sulphur is represented by sublimed, precipitated, and black sulphur. The latter is formed by heating sulphur to 600°, and suddenly cooling it.

Sulphur inflames at about 500°, and burns with a blue flame, forming suffocating fumes of sulphurous anhydride (SO_2). At the boiling point, 836°, it evolves a deep yellow vapour of sp. gr. 6·617, one volume of which contains 3 atoms of sulphur. Crystalline sulphur is soluble in boiling anhydrous alcohol; freely in boiling turpentine, 1½ per cent. being retained on cooling; and still more freely in benzol and in carbonic disulphide, 3 parts of which will dissolve 1 of sulphur. Chloroform and æther are but feeble solvents. It dissolves in most fatty and essential oils. It is insoluble in water, is a bad conductor of heat, an insulator of electricity, and when rubbed becomes negatively electric.

Sulphur is an exceedingly important chemical agent, forming Sulphurets or Sulphides with the various metals, for the most part corresponding to their oxides. With Oxygen it forms seven acids, of which Sulphurous and Sulphuric are the chief; with Hydrogen, Hydrosulphuric acid, or Sulphuretted Hydrogen. It readily unites with chlorine, iodine, and bromine.

Tests of Purity.—Crude sulphur contains various metallic and earthy impurities, and that obtained from pyrites is usually contaminated with orpiment (As_2S_3). When pure it should completely evaporate at 500°, and wholly dissolve in boiling oil of turpentine. It should have no action on litmus. Solution of ammonia agitated with it, and filtered, leaves no residue on evaporation (proving the absence of orpiment and mineral acids).

Action.—Only a small portion of Sulphur is absorbed in its passage through the alimentary canal, the bulk acting as a mechanical irritant, and so producing a mild purgative action. That absorbed is eliminated as hydrosulphuric and sulphuric acids; the sulphates of the urine and other fluids are increased; and all the secretions, especially those of the alimentary canal and skin, are impregnated with sulphuretted hydrogen. Silver in contact with the cutaneous emanations of the patient is blackened. Since Taurin, an essential constituent of the bile, contains 25 per cent. of its weight of sulphur, it is evident that this element may sometimes be required as a restorative. In doses of from 5 to 20 grains, Sulphur is a gentle stimulant to the excretory glands, especially those of the skin and mucous membrane. In doses of from 1 to 4 drachms, it gently excites peristaltic action of the intestines.

1. **Sulphur Sublimatum,** *P.B.* *Sublimed Sulphur.* *Flowers of Sulphur.*

Prepared by reducing Sulphur to a coarse powder, and then subliming from a large iron retort into a sulphur-room, where the vapour is immediately condensed. A little sulphurous acid is formed in the process of sublimation, hence the necessity of washing until the water fails to give an acid reaction to litmus.

Characters and Tests.—A slightly gritty powder, composed of microscopic granules, of a fine greenish-yellow colour, tasteless and odourless, except when heated; burning in open vessels with a blue flame, and evolution of sulphurous acid. Entirely volatilised by heat (absence of earthy impurity); does not redden moistened litmus paper (freedom from sulphurous and sulphuric acids). Solution of ammonia agitated with it, and filtered, does not on evaporation leave any residue (absence of sesquisulphide of arsenic). If the ammoniacal washings should yield a residue containing arsenic, it may be detected by redissolving in ammonia and supernaturating with hydrochloric acid, when golden yellow arsenious sequisulphide or orpiment falls. (See tests for Arsenic.)

Dose.—20 grains to half an ounce. Treacle is the best vehicle for the drug. Half a pound of the latter may be mixed with a pound of treacle, and a dessert or tablespoonful, according to age, taken as a laxative.

Pharmaceutical Uses.—Sublimed sulphur is used in the following preparations, and also in the Emplastrum ammoniaci cum hydrargyro, and Emplastrum hydrargyri; in the Iodide of sulphur, Sulphurated potash, and Sulphuric acid.

2. **Sulphur Præcipitatum,** *P.B. Precipitated Sulphur. Lac Sulphuris,* or *Milk of Sulphur.*

Preparation.—Heat 5 ounces of *sublimed sulphur*, previously well mixed with 3 ounces of *slaked lime*, in a pint of water, stirring diligently with a wooden spatula, boil for fifteen minutes, and filter. Boil the mixture again in half a pint of water, and filter. Let the united filtrates cool, dilute with 2 pints of water, and, in an open place and under a chimney, add in successive quantities 8 fluid ounces of *hydrochloric acid*, or a sufficiency, previously diluted with a pint of water, until effervescence ceases and the mixture acquires an acid reaction. Wash the precipitate in successive portions of distilled water until the fluid ceases to have an acid reaction, and to precipitate solution of oxalate of ammonia. Collect the precipitated sulphur on a calico filter, and dry at a temperature not exceeding 120°.

When slaked lime is boiled with excess of sulphur, calcic pentasulphide and hyposulphite are formed in solution:

$$3CaO+12S+H_2O=2CaS_5+CaS_2H_2O_4.$$

On the addition of hydrochloric acid, water, calcic chloride, and sulphur are formed, the latter of course being precipitated.

Properties.—A greyish-yellow impalpable power composed of molecules, much smaller than the microscopical granules of sublimed sulphur. On this account it is most suitable for medicinal use.

Tests of Purity.—Those of sublimed sulphur. Precipitated sulphur is now generally disused on account of the fraudulent substitution of sulphuric for hydrochloric acid in its preparation. When the former acid is used, both lime and sulphur are precipitated, the former, as insoluble sulphate, forming the chief portion of the precipitate. Sublimation detects the impurity. After burning off the sulphur in an iron spoon, the *Sulphate of lime* remains, and its weight may be found; but the microscope is the readiest test, revealing abundance of minute and imperfect flattened prisms of *selenite* ($CaSO_4 2Aq$).

3. **Oleum Sulphuratum,** *P.B. Sulphurated Oil. Balsamum Sulphuris. Balsam of Sulphur.*

It may be obtained by dissolving *Sulphur* (1 part) and *Olive Oil* (8 parts) by boiling together in a large iron vessel. It is a dark reddish-brown viscid substance, having a very disagreeable odour of sulphuretted hydrogen.

Dose.—5 to 20 grs. twice or thrice a day as a stimulant and diaphoretic; gr. 60–120 as a laxative; but it is unfit for internal use.

Pharmaceutical Uses.—As a medicinal agent this preparation is now omitted from the Pharmacopœia, but it is employed as a means of facilitating the subdivision of metallic mercury in the preparation of Emplastrum ammoniaci cum hydrargyro and Emplastrum hydrargyri.

4. **Unguentum Sulphuris**, *P.B.* *Sulphur or Brimstone Ointment.*

Preparation.—Mix thoroughly 1 ounce of *Sublimed sulphur* with 4 ounces of *benzoated lard.*

Action. Uses.—In scabies it is specific by destroying the Acarus. In porrigo, impetigo, and acne it is a useful stimulant.

5. **Confectio Sulphuris**, *P.B.* *Confection of Sulphur.*

Preparation.—Rub well together 4 ounces of *sublimed sulphur*, 1 ounce of *acid tartrate of potash*, and 4 fluid ounces of *syrup of orange peel.*

Dose.—Grs. 60–120 act as a mild laxative, especially in hæmorrhoids.

OXYDES OF SULPHUR.—The following compounds of Sulphur Oxygen are used in and medicine:—

Sulphurous acid, $HOSO_2 = 41$, or $\mathbf{H_2SO_3} = 82$
Sulphuric acid, $HOSO_3 = 49$, or $\mathbf{H_2SO_4} = 98$
Hyposulphurous acid, $2H.O,S_2O_2 = 66$, or $\mathbf{H_2S_2H_2O_4} = 132$.

ACIDUM SULPHURICUM.

Sulphuric Acid. F. *Acide Sulphurique.* G. *Schwefelsäure.*

This important acid occurs in small quantities in nature in volcanic regions. One river containing the free acid issues from the crater of Mont Idor in Java, while another similar stream issues from the volcano of Puracé in Columbia. Sulphates are abundant in nature; water is rarely or never free from them. Gypsum (calcic sulphate) and Epsom salts (magnesic sulphate) may be taken as familiar examples. Sulphuric acid was known to the Arabs, Persians, and Hindoos.

Sulphuric acid appears, from its names, to have been originally made in Europe, and probably also in Persia, from the decomposition of vitriol or sulphate of iron, a practice still followed at Nordhausen in Saxony. The sulphate is first calcined, so as to expel nearly the whole of its water of crystallisation. The acid is then distilled from an earthenware retort at a red heat; it comes over as a white vapour, which condenses into a dark-coloured oily-looking liquid. It fumes when exposed to the air, has a sp. gr. of 1·9, and is known in commerce as the Nordhausen, Fuming, or Glacial sulphuric acid. If the white vapour arising from the acid, when gently heated in a glass retort, be received into an ice-cold receiver, a colourless asbestos-like mass is deposited. This is anhydrous sulphuric acid, or sulphuric anhydride ($SO_3=80$).

At 65° it melts, and boils at 112°. Sp. gr. 1·97. The dry acid does not redden litmus; when exposed to the air, dense white fumes are produced from condensation of moisture. In contact with water it produces as much hissing as a piece of hot iron, and forms by combination with the water a solution of ordinary sulphuric acid. There are at least four definite compounds of sulphuric anhydride with water. The first contains 2 eq. of the anhydride to 1 of water (Nordhausen Oil of vitriol); the second is the monohydrate (Oil of vitriol); the third, containing 2 eq. of water to 1 of SO_3 (Glacial sulphuric acid); and the fourth, composed of 3 eq. of water to 1 of SO_3.

Monohydrated Sulphuric Acid, $HOSO_3=49$ or $H_2SO_4=98$. *Dihydric Sulphide. Oil of Vitriol. Vitriolic Acid.*

Properties.—A dense oily-looking liquid, of sp. gr. 1·848, colourless and inodorous, but intensely acid and corrosive. At first it feels oily, from destroying the cuticle, but soon acts as a caustic, charring both animal and vegetable substances by combining with the water and setting free the carbon. It freezes at 29°, and boils at 640°, and distils unchanged. Its affinity for water is great, heat and condensation being produced by their union. It absorbs moisture from the air—$\frac{1}{3}$ of its weight in 24 hours, and 6 times its weight in a twelvemonth, and consequently becomes weaker the longer it is exposed. It owes its chemical activity to two qualities—a great affinity for water, and a capacity for imparting oxygen. By virtue of the first, it converts sugar into a mass of carbon, and alcohol into æther; and by virtue of the second, it is reduced to sulphurous acid when heated with charcoal, phosphorus, sulphur, copper, lead, tin, mercury, bismuth, arsenic, antimony, and silver, sulphates of the metal being at the same time formed thus :—

$$Ag_2+2H_2SO_4=Ag_2SO_4+SO_2+2Aq\,.$$

The more oxydisable metals, zinc, iron, cobalt, nickel, and manganese are dissolved by the dilute acid, hydrogen being liberated, while the Sulphion (SO_4) unites with the metal to form a sulphate. Sulphuric acid is the most powerful of the acids, and displaces from their salts all other acids.

Preparation.—*Sulphurous acid gas, nitric acid vapour, air,* and *steam* are simultaneously admitted into oblong leaden chambers containing water at the bottom. The Sulphurous acid (SO_2) is obtained by burning sulphur in a proper furnace. The Nitric acid vapour is produced separately by heating nitre (nitrate of potash) with sulphuric acid in an iron pot. Sulphate potash is formed, and nitric acid (HNO_3) set free. The quantity of nitre used is about $\frac{1}{12}$ of the sulphur burnt. Steam is caused to encounter these two acid gases where they meet in the leaden chamber, which is long, and intersected by partitions nearly reaching to the bottom, in order that the vapours may pass through it slowly, and have thus more time to react upon each other.

The reaction is simple. The Nitric acid is deoxidised by the sulphurous anhydride to the state of nitric oxyde:—$3SO_2+2HNO_3+2H_2O=3H_2SO_4+2NO$.

The *Nitric oxyde* thus formed immediately absorbs oxygen from the air, and is converted into peroxyde (NO_2), which is rapidly reduced, again by the Sulphurous acid to Nitric oxyde:—$SO_2+NO_2+H_2O=H_2SO_4+NO$; the nitric oxyde thus acting as a carrier of oxygen from the air to the sulphurous acid, itself meanwhile undergoing no diminution, a small quantity theoretically being able to convert an indefinite quantity of sulphurous into sulphuric acid. As it is formed, the latter trickles down the leaden walls of the chamber, and is dissolved in the water at the bottom, which becomes gradually converted into liquid Sulphuric acid of considerable strength. When it has attained a density of 1·5, beyond which it absorbs nitrous fumes, it is drawn off, and evaporated in shallow leaden pans to a sp. gr. of 1·72. As leaden vessels cannot be longer used on account to their liability to melt, and to erosion by the acid, the further concentration of the acid is effected in glass or platinum retorts, until it has a sp. gr. of 1·84. When cooled, it is removed into large carboys, and forms the *Oil of Vitriol* of commerce.

1. **Acidum Sulphuricum**, *P.B.* *Sulphuric Acid.*

An acid, produced as above, by the combustion of sulphur and the oxydation of the resulting sulphurous acid by means of nitrous vapours. It contains 96·8 per cent. by weight of Sulphuric acid, HO,SO_3 or HSO_4, and corresponds to 79 per cent. of anhydrous acid, SO_3 or SO_3.

Characters and Tests.—A colourless (free from organic matter) liquid, of oily appearance, intensely acid and corrosive, sp. gr. 1·843 (that of the Oil of Vitriol of commerce). It evolves much heat (from condensation) on the addition of water, and when thus diluted gives a copious precipitate ($BaSO_4$) with chloride of barium. 50·6 grains, mixed with an ounce of water, require for neutralisation 1000 grain meas. of the volumetric solution of soda. Evaporated in a platinum dish, it leaves little or no residue (a trace of sulphate of lead). When a solution of sulphate of iron is carefully poured over its surface, there is no purple colour (see p. 71, showing absence of oxydes of nitrogen) developed where the two liquids unite. Diluted with six times its volume of water, it gives no precipitate with sulphuretted hydrogen (the trace of sulphate of lead falls on dilution, and if arsenic be present, a yellow precipitate is formed). The slightest trace of colour indicates the presence of organic matter.

Impurities.—Commercial sulphuric acid is usually contaminated with the *oxydes of nitrogen*, *sulphate of lead*, and, when the sulphur used in its manufacture has been obtained from iron pyrites, with *Arsenious acid.* Dr C. O. Rees found 22·58 grains of this acid in a fluid pint of oil of vitriol, and Mr Watson states that the smallest quantity which he has detected in the same quantity of acid is 35½ grains. Marsh's test (see Arsenious acid) is most conveniently employed for the detection of this impurity.

Purification.—The arsenic is first removed by the addition of a little sulphide of barium. Sesquisulphide of arsenic and sulphate of barium are formed, both being insoluble in the acid, may be separated by subsidence. The decanted acid may be freed from its other impurities by redistillation from a glass retort containing fragments of colourless quartz or platinum foil, and a little ammonic sulphate (100 grains to a pound of the acid). The latter decomposes the oxydes of nitrogen; while the former moderates the ebullition. The perfectly pure acid should give no turbidity or subsequent precipitate ($PbSO_4$) when diluted with thrice its bulk of water.

Incompatibilities.—Alkalies; oxydes, such as magnesia; chlorates, acetates, citrates, tartrates, and carbonates; and salts of lime, baryta, and lead.

SULPHATES.—Sulphuric acid displaces from their combinations all acids which boil at a lower temperature than itself. The sulphates of the metals of the alkalies, alkaline earths (excepting sulphate of magnesia), and of lead, are not decomposed by a red heat: the sulphates of zinc, cadmium, copper, and silver are decomposed by an intense heat. All other sulphates (*e.g.*, sulphate of iron) part with acid when strongly heated. All are decomposed when heated with charcoal, being converted into sulphides. Sulphate of baryta may thus be readily recognised, $BaSO_4+4C=BaS+4CO$. A drop of hydrochloric acid evolves H_2S from the BaS immediately, and the solution gives a precipitate ($BaSO_4$) with a soluble sulphate or a drop of diluted sulphuric acid. The formation of this precipitate, on the addition of nitrate of baryta, is the test for a soluble sulphate or free sulphuric acid. A soluble salt of lead also produces a heavy white precipitate. Both are insoluble in nitric acid.

Pharmaceutical Uses.—The preparation of Acidum sulphuricum aromaticum, Acidum sulphuricum dilutum, Infusum rosæ acidum.

Antidotes.—Magnesia, chalk, whiting, soap. Dilution. Demulcents.

2. **Acidum Sulphuricum dilutum,** *P.B.* *Diluted Sulphuric acid.*

Preparation.—Add gradually 7 fluid ounces of *sulphuric acid* to 77 fluid ounces of *water*, and when the mixture has cooled to 60° add more water, so that it shall measure 83½ fluid ounces. Or as follows:—Weigh 1350 grains of *sulphuric acid* in a glass flask, the capacity of which, to a mark on the neck, is one point, then gradually add *water* until the mixture, after it has been shaken and cooled to 60°, measures a pint.

In mixing Sulphuric acid and water, the former should always be added to the latter, slowly, in a fine stream. If the water be added to the acid, the great heat which is suddenly evolved will probably crack the vessel. The mixture is always attended with condensation, and unless the acid be pure, a scanty dull white precipitate of *sulphate of lead* occurs.

Tests.—Sp. gr. 1·094. 359 grains (6 fluid drachms) require for neutralisation 1000 gr. meas. of the volumetric solution of soda, corresponding to 10·14 per cent. of anhydrous Sulphuric acid. Six fluid drachms, therefore, correspond to 40 grains of the anhydrous acid (one equivalent of SO_3, or half an equivalent of SO_3).

Action and Uses of Sulphuric Acid.—In an undiluted state, Sulphuric acid is a violent corrosive poison, completely destroying the parts with which it comes in contact. When given in excess medicinally, it is apt to produce irritation of the intestinal canal. In small doses properly diluted, it may be given when it is desirable to produce an acid reaction, or *to counteract alkalinity* in any of the secretions. Tending to render the urine acid, it is useful in cases of alkaline urine with Phosphatic deposits. Or it may be prescribed in Dyspepsia, when accompanied by an alkaline condition of the secretions. In the second place, this acid is a powerful *Astringent.* It checks secretion, counteracts hæmorrhage, and braces the muscular tissue throughout the body. It may be used in Hæmoptysis, Melæna, or profuse Sweating. It is often united with Tonics in simple Debility. It is said to be of especial use in atonic Diarrhœa. Lastly, like other acids, it is given in drinks to allay thirst in pyrexia; whence it gains the title of *Refrigerant.*

Dose.—5 to 30 minims in water, or some bitter infusion.

Pharmaceutical Uses.—It is an ingredient of *Infusum Rosæ Acidum*, which contains 6 minims in a fluid ounce.

3. **Acidum Sulphuricum aromaticum,** *P.B. Aromatic Sulphuric acid.*

Preparation.—Mix 3 fluid ounces or 2419 grains of *sulphuric acid* gradually with 2 pints of *rectified spirit*, add 2 ounces of *cinnamon* bark, and 1¼ ounce of *ginger*, both in coarse powder, macerate for seven days, agitating frequently, then filter.

This is a simple form of the acid elixir of Mynsicht, and is a pleasant method for exhibiting Sulphuric acid, as it is merely diluted with spirit instead of with water, with the addition of aromatic principles.

Tests.—Sp. gr. 0·927. 304·2 grains (6 fluid drachms) require for neutralisation 830 grain meas. of the volumetric solution of soda. Six fluid drachms, therefore, correspond to 33·2 grains of anhydrous acid, or 10·91 per cent.

Dose.—5 to 30 minims.

ACIDUM SULPHUROSUM, *P.B.:* $HO,SO_2=41$ or $H_2SO_3=82$. *Solution of Sulphurous Acid gas*, or *Sulphurous anhydride in water*, and constituting 9·2 per cent. by weight of the solution.

Preparation.—Put 1 ounce of *wood charcoal*, broken into small pieces, and 4 fluid ounces of *sulphuric acid* into a glass flask, connected by a glass tube with a wash-bottle containing 2 ounces of water, whence a second tube leads into a pint bottle containing 1 pint of water, to the bottom of which the gas-delivery tube should pass. Apply heat to the flask until gas is evolved, which is to be conducted through the water in the wash-bottle, and then into the water in the larger bottle, the latter being kept cold, and the process being continued until the bubbles of gas pass through the solution undiminished in size. The product should be kept in a stoppered bottle in a cool place.

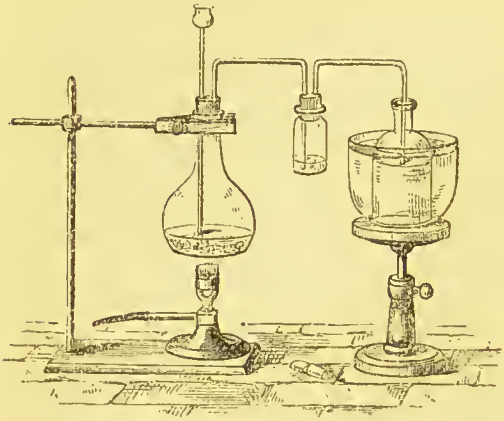


Fig. 22.

In the above process the sulphuric acid is reduced by the carbon to SO_2, carbonic acid, or as it is now called carbonic anhydride, and water being formed thus :—

$$C+2HOSO_3=2HO+CO_2+2SO_2 \text{ , or}$$
$$C+2H_2SO_4=2H_2O+CO_2+2SO_2 \text{ .}$$

The wash-bottle arrests the CO_2 and other impurities, as well as some portion of the SO_2. Sulphurous anhydride, SO_2 or SO_2, combines immediately with water to form sulphurous acid, $HOSO_2$ or H_2SO_3. The gas is freely soluble in water, which absorbs at 32°, 68·8 times its bulk; at 59°, 43·5; and at 75°, 32 times its volume of the gas.

Characters and Tests.—A colourless liquid, with a pungent sulphurous odour. Sp. gr. 1·04. It gives no precipitate, or only a very slight one ($BaSO_4$) with chloride of barium, but a copious one if solution of chlorine be also added. The solution gradually absorbs oxygen from the air, and becomes converted into dilute sulphuric acid, and a little is formed during the solution of the gas in the water. Chlorine, by virtue of its great affinity for hydrogen, at once determines this change, the oxygen being derived from the decomposed water thus :—$SO_2+Cl_2+2H_2O=2HCl+H_2SO_4$, a mixture of hydrochloric and sulphuric acids resulting. Iodine, in like manner, forms with it hydriodic and sulphuric acids :—$SO_2+I_2+2H_2O=2HI+H_2SO_4$. 34·7 grains of the solution, mixed with an ounce of water and a little mucilage of starch, does not acquire a permanent blue colour with the volumetric solution of iodine, until 1000 gr. measures have been added. (Hydriodic acid does not turn starch blue. At the point mentioned, the iodine is just in excess). When evaporated, it leaves no residue. Owing to its affinity for oxygen, sulphurous acid is useful as an oxydising agent.

It combines with alkalies and metallic oxydes to form soluble SULPHITES. The presence of a trace of sulphite is readily determined by the addition of a fragment of zinc and a few drops of hydrochloric acid to the solution, the SO_2 is deoxydised, and sulphuretted hydrogen formed by union of the S with nascent hydrogen, thus:—$SO_2+H_5+2H_2O+HS$. A little moistened lead-paper readily detects the latter.

Action and Uses.—As produced by burning sulphur, SO_2 in the form of gas has been used for bleaching and as a disinfectant from ancient times. It decomposes sulphuretted hydrogen with the precipitation of sulphur, and thus removes bad smells. It destroys the vitality of minute vegetable and animal organisms, and as these are necessary agents in both the putrefactive and fermentative decompositions, it completely prevents these processes. Thus, meat may be preserved fresh for years by first exposing it to the action of SO_2, and then sealing it in canisters from which the air has been displaced by nitrogen; and the fermentation of beer or cyder may be checked by burning a little sulphur in the cask before filling it with the liquor. For the same reason, sulphurous acid gas is an antidote to those diseases of the skin which depend on the presence of a fungus. It is extremely serviceable in that form of fermentative dyspepsia which is associated with the development of Sarcina ventriculi. It is also useful in scabies, in cases where the sulphur ointment may be objectionable.

In the cutaneous diseases above referred to, it is often desirable to expose the whole of the surface, as well as the underclothing of the patient, to the action of the remedy, and this may be effected by burning ½ oz. of sulphur, contained in an iron capsule, in a wooden box or confined chamber large enough to receive the body of the patient sitting on a cane chair. A little steam should be at the same time admitted into a corner of the chamber, and means adopted to prevent the fumes from reaching the face of the patient. Sulphurous acid, or "sulphur baths," have proved serviceable in other diseases of the skin,—viz., chronic eczema, impetigo, and psoriasis.

Dose.—The solution of the Pharmacopœia may be applied undiluted, or mixed with an equal quantity of water. The dose for internal use is from ½ to 1 fl. dr. in some aromatic water.

HYPOSULPHUROUS ACID, $2HO,S_2O_2=66$ or $H_2S_2H_2O_4=132$, Is only known in Pharmacy in combination with soda. See Hyposulphite of Soda.

SULPHURETTED HYDROGEN: $HS=17$ or $H_2S=34$.

Dihydric Sulphide. Hydrosulphuric Acid. F. *Acide Hydro-Sulfurique.* G. *Schwefelwasserstoffsäure.*

Properties.—It is a colourless gas, of the odour of rotten eggs. 100 cu. in. weigh 38 grs. Sp. gr. = 1·174. It has been reduced to a clear colourless liquid by a pressure of 17 atmospheres. It is inflammable, sulphurous acid and water being produced. Water absorbs about 2½ times its bulk, acquiring the taste and smell of the gas, as well as its acid property of reddening litmus. On exposure to the air some H_2S escapes; the remainder is gradually decomposed, the H being oxydised to form water, and the sulphur precipitated, causing turbidity of the fluid.

It combines with bases, and forms hydrosulphates, as that of ammonia; or sulphides, some of which are black, others red, white, orange, and yellow. Sulphuretted hydrogen is absorbed in large quantities by charcoal, and is exhaled from putrefying animal and vegetable matters. When a sulphate is present in the decomposing matters, it is converted into a sulphide by loss of oxygen, which combines with the decaying matter. The sulphides contained in mineral waters, such as Harrowgate (see p. 48), are commonly derived in this manner from decaying vegetable matter.

Preparation.—Put $\frac{1}{2}$ an ounce of *sulphide of iron*, with 4 ounces of water, into a bottle closed by a cork with two holes (fig. 23), one of which is fitted with a tubular funnel dipping below the surface of the fluid, and the other with a tube to give exit to the gas. Pour a little *sulphuric acid* through the funnel from time to time, so as to develop the H_2S as it may be required, $FeS + H_2SO_4 = FeSO_4 + H_2S$. The gas should be passed through a little water in a wash bottle, as shown in the fig., before it is conveyed into the solution to be tested.

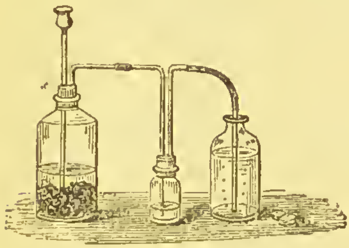


Fig. 23.

Action. Uses.—Most deleterious when respired, even if much diluted. Mineral waters, either natural (as of Harrowgate) or artificial, taken internally, or used externally in the form of a bath, are stimulant, especially to the functions of the skin and of the uterine system. H_2S is much used as a test. It should be freshly prepared.

The following tabular statement exhibits the behaviour of sulphuretted hydrogen with *acidified* solutions of the metallic compounds treated of in this work:—

1. No Precipitate with

Alumina.
Baryta.
Calcium.
Chromium.
Iron, protoxide.
Lithia.
Magnesia.
Manganese.
Potash.
Soda.
Strontia.
Zinc.

2. A Precipitate with

Antimony (orange red).
Arsenic (yellow).
Bismuth (black).
Cadmium (bright yellow).
Chromium (oxyde and sulphur).
Copper (black).
Gold (black).
Iron, peroxyde (precipitated sulphur).
Lead (black).
Mercury (black, or becoming so).
Platinum (brownish black).
Silver (black).
Tin, protoxide (brownish black).
Tin, peroxyde (yellow).

The solutions to be tested should be acidified with a few drops of hydrochloric acid before the gas is passed through them. *Neutral solutions* of protosalts of iron, manganese, and zinc give each a slight precipitate of black, flesh-coloured, and white sulphide respectively with H_2S.

The following reactions deserve attentive consideration, as they have an influence in many pharmaceutical processes:—When H_2S is passed through a solution of ammonia, potash, soda, lime, or baryta, hydrosulphates of potash K_2O,H_2S, of ammonia H_4NO,H_2S, and of the others, are formed, which remain in solution and absorb another equivalent of H_2S if the gas be in excess. These solutions smell strongly of H_2S. The hydrosulphates may be otherwise regarded as sulphides, for $K_2O,H_2S = K_2S$ sulphide of potassium, $+ H_2O$ water. When a metallic salt is precipitated by H_2S, a sulphide of the metal is actually precipitated; thus, $CuSO_4 + H_2S = H_2SO_4 + CuS$, the solution becoming acid from the liberation of H_2SO_4. When the metal is too firmly combined with the salt-radicle to be separated by H_2S, this may be accomplished by simultaneously presenting to it an alkali; hence the use of hydrosulphate of ammonium (H_4NHS) as a precipitant.

Tests.—The peculiar odour. The least trace may be detected by means of a bit of bibulous paper moistened with a solution of acetate of lead, the paper blackening immediately it comes in contact with the gas.

Antidotes.—Inhalation of chlorine, and acids taken internally.

PHOSPHORUS: $P = 31$ or $P = 31$. Comb. vol. $\frac{1}{2}$.

F. *Phosphore.* G. *Phosphor.*

Phosphorus, from φῶς, *light*, and φέρω, *to bear*, was discovered by Brandt in 1669. He separated it from the phosphates of urine; but it is now procured almost entirely from the ashes of bones, which consist chiefly of tricalcic phosphate. It is an important constituent of nerve tissue, and is found in all animal and vegetable juices. It occurs in the mineral kingdom in the form of phosphates, which give fertility to some soils.

Preparation.—It is obtained on the large scale by the action of sulphuric acid on powdered bone-ash; 3 parts of the latter are mixed with 2 of the former, diluted with 20 parts of water. After three days the acid liquid is separated from the calcic sulphate, evaporated to a syrupy consistence, mixed with about one-third its weight of powdered charcoal, and heated to dryness. It is then transferred to an earthen retort, terminating in a wide copper tube dipping into water, and slowly heated to redness (fig. 24). At this temperature P distills and condenses beneath the water in yellow drops, while hydrogen and carbonic oxyde gases bubble upwards through the water and escape. The P is subsequently remelted under water, purified, and cast into sticks.

In the first stage of the process, two-thirds of the lime are removed by the sulphuric acid as insoluble calcic sulphate, and the remainder, in union with the whole of the phosphoric acid, forms a soluble superphosphate, or acid calcic phosphate; thus, according to the new notation:—

$$\overbrace{Ca_3 2PO_4}^{\text{Tricalcic Phosphate.}} + \overbrace{2H_2SO_4}^{\text{Sulphuric Acid.}} = \overbrace{2CaSO_4}^{\text{Calcic Sulphate.}} + \overbrace{H_4Ca2PO_4}^{\text{Acid Calcic Phosphate.}} .$$

When the superphosphate is heated with charcoal, tribasic phosphate is re-formed, and phosphoric acid set free:—

$$3(H_4Ca2PO_4) = Ca_3 2PO_4 + 4H_3PO_4 .$$

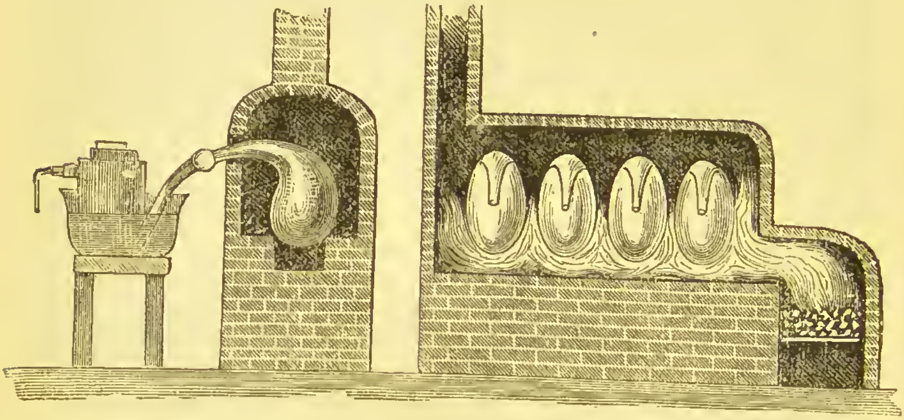


Fig. 24.

The last stage of the process consists in the decomposition of the acid as soon as it becomes free; thus, $4H_3PO_4 + 16C = 12H + 16CO + 4P$, sixteen atoms of charcoal being sufficient for the complete deoxydation of four equivalents of phosphoric acid.

Properties.—Phosphorus is a soft, flexible, semi-transparent, wax-like solid, sp. gr. = 1·77, colourless or yellowish, tasteless. On exposure to the air it evolves white garlicky fumes; it becomes luminous in the dark, in consequence of its combination with oxygen. It is so inflammable as to take fire spontaneously in the open air; hence it is requisite to keep it under water, as the least friction excites heat enough to ignite it.* When air is excluded, it melts at 111°·5 Fahr., and boils at 550°, passing off as a colourless vapour; at 32° it is crystalline and brittle, and from its solution in hot naphtha it may be obtained in dodecahedral crystals. Phosphorus is insoluble in water; it is slightly soluble in æther, moderately so in turpentine and the other essential oils, and in benzol and the fixed oils; and it is freely soluble in chloride of sulphur, in phosphorous chloride, and in carbonic dichloride. Phosphorus, like sulphur, is allotropic, existing in the following five different forms:—1. The transparent or *vitreous* variety above described. 2. *White*, opaque P, derived from 1 by exposure to light and water. 3. *Black* P, obtained by suddenly cooling melted P. 4. *Viscous* P, formed by heating pure P to near its boiling point, and suddenly cooling it. 5. *Red*, or amorphous P, made by heating dry P in a flask full of carbonic anhydride, to between 446° and 464° for 30 or 40 hours. It is a remarkable variety, having the colour of vermilion; it is destitute of odour, has a sp. gr. of 2·14, and may be heated in the open air without change to 500°, it then melts, bursts into a large body of flame, emitting white fumes of phosphoric anhydride.

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* Lucifer or Congreve matches are generally tipped with a paste made of phosphorus 10 parts, gelatine, red lead, and nitre, 25 parts each.

Tests.—Easily recognised by the above characters. Soluble in æther and in boiling oil of turpentine.

Action. Uses.—Phosphorus is an irritant poison. It is absorbed and enters the blood in an unoxydised condition, being held in solution in the serum. In doses of from 1 to 5 grains it has produced fatal depression of nervous power, especially of the vaso-motor system (Habershon, "Medico-Chir. Trans.," vol. l. p. 96), fatty degeneration of the liver and intestinal glandulæ occurs. In the course of a few days, jaundice, suppression of urine, vomiting of bilious or sanguinolent matters, and a fluid condition of the blood. Resulting ecchymoses in the skin and mucous and serous membranes appear, and the temperature, which has never been increased, rapidly falls. In medicinal doses ($\frac{1}{10}$ of a grain) it is a stimulant to the nervous system, and may be given where there is a tendency to nervous prostration and general enfeeblement, as in the early stages of the palsy of the insane; and in cases of cerebral or spinal atrophy. P has long been regarded as an aphrodisiac, and may sometimes be given with benefit when there is sexual debility. Oil is the proper menstruum.

Antidotes.—At first an emetic; afterwards a full dose of castor oil, which, at the same time that it dissolves the poison, carries it out of the body. Subsequently demulcents. Persons exposed to the fumes of P, as in the manufacture of lucifer matches, become cachetic, and often suffer necrosis of the lower jaw. This evil may be avoided by the use of amorphous (red) phosphorus, which exhales no vapour, and may be swallowed with impunity.

Pharmaceutical Uses.—Phosphorus is employed in the two preparations next following, and in the Acidum phosphoricum dilutum.

1. **Oleum Phosphoratum,** *B.P.* *Phosphorated Oil.*

Preparation.—Heat *Oil of Almonds* in a porcelain dish to 300°, and keep it at this temperature for 15 minutes, then let it cool, and filter through paper. Put 4 fluid ounces of this oil into a stoppered bottle capable of holding 4½ fluid ounces, and add to it 12 grains of *Phosphorus.* Immerse the bottle in hot water until the oil has acquired the temperature of 180°, removing the stopper twice or thrice to allow the escape of expanded air, then shake the oil and phosphorus together until the latter is entirely dissolved.

The object of heating the oil in an open vessel is to drive off any water, and to precipitate any albumen that may be contained in it,

M. Méhu having shown that the presence of these substances cause, after a time, the separation of a portion of the phosphorus.

Characters.—A clear and colourless, or but slightly coloured oil; phosphorescent in the dark.

Dose.—5 to 10 minims, formed into an emulsion with Pulvis amygdalæ compositus.

2. **Pilula Phosphori,** *P.B.* *Phosphorus Pill.*

Preparation.—Put 2 grains of *phosphorus* and 120 grains of *balsam of Tolu* into a Wedgewood mortar about half full of hot water, and when the phosphorus is melted and the balsam has become sufficiently soft, rub them together beneath the surface of the water until no particles of phosphorus are visible, the water being kept at or near 140°. Add now the wax, and, as it softens, mix it thoroughly with the other ingredients. Allow the mass to cool, excluded from the air, and keep it in a bottle immersed in cold water. It may be softened with a few drops of spirit for use.

Dose.—3 to 6 grains.

OXYDES OF PHOSPHORUS.—Phosphorus forms four compounds with oxygen:—(1) Oxyde of phosphorus, a neutral insoluble compound; and three acids, viz., (2) Hypophosphorous acid, HPH_2O_2 (monobasic); (3) Phosphorous acid, H_2PHO_3 (dibasic); and (4) Phosphoric acid H_3PO_4 (tribasic). The latter two exist in the anhydrous state.

PHOSPHORIC ACID.

F. *Acide Phosphorique.* G. *Phosphorsäure.*

This is the most important of the compounds of phosphorus and oxygen. Phosphoric anhydride (P_2O_5) may be readily obtained by burning P in dry air or oxygen. It is a snow-white, flocculent, amorphous, and deliquescent powder, which combines with water with a hissing noise, and forms a solution of ordinary Phosphoric acid, $P_2O_5 + 3H_2O = 2H_3PO_4$. It was first distinguished in 1760 by Marggraff. There are three varieties of phosphoric acid, each of which possesses the properties of a distinct acid:

Metaphosphoric acid,	HO,PO_5 or HPO_3
Ortho- or ordinary phosphoric acid,	$3HO,PO_5$ or H_3PO_4
Pyrophosphoric acid,	$2HO,PO_5$ or $H_4P_2O_7$.

When dissolved in water these acids form salts with 1, 3, and 4 equivalents of base respectively. Ordinary or tribasic acid is the only one requiring our consideration in this work. Its preparation in the dilute form is best effected as follows:—

1. **Acidum Phosphoricum dilutum,** *B.P.* *Dilute Phosphoric Acid.*

Phosphoric acid, $3HO,PO_5$ or H_3PO_4 dissolved in water, and corresponding to 10 per cent., by weight of anhydrous Phosphoric acid, $PO_5 = 71$ or $P_2O_5 = 142$.

Preparation.—Put 6 fluid ounces of *nitric acid*, diluted with 8 ounces of water, into a tubulated retort connected with a

Liebig's condenser, and having added 413 grains of *phosphorus*, apply a gentle heat so as slowly to distil 5 fluid ounces of liquid. Return this to the retort, and continue the distillation, occasionally returning the distillate, until the phosphorus has entirely disappeared. Transfer the contents of the retort to a porcelain dish of hard well-enamelled ware, and evaporate the liquid until it is reduced to 4 fluid ounces; then, transferring it to a platinum vessel, continue the evaporation until it is reduced to about 2 fluid ounces, and orange-coloured vapours are no longer formed. Mix it now with distilled water until when cold it measures one pint.

In this process, the P deoxydises the nitric acid, converting it into nitric oxyde (**NO**), which escapes and forms ruddy fumes by conversion into peroxyde of nitrogen as soon as it comes into contact with the air. Undecomposed nitric acid also escapes, and the object of distillation is to recover it. As soon as the phosphorus is dissolved, this is no longer necessary, and the excess of acid is dissipated in the process of evaporation. If this be continued until dense white fumes (phosphoric anhydride) arise, a transparent glassy mass (glacial phosphoric acid, sp. gr. 2·0) remains. The Pharmacopœia process stops a little short of this. Dilute nitric acid is used in order to avoid explosive ignition of the P.

Characters and Tests.—A colourless liquid of sour taste and acid reaction; sp. gr. 1·08. It readily combines with the alkalies and metallic oxydes; 355 grains by weight poured upon 180 grains of oxyde of lead in fine powder leave, by evaporation, a residue (principally phosphate of lead), which, after it has been heated to dull redness, weighs 215·5 grains. Six fluid drachms therefore correspond to 35·5 grains of anhydrous phosphoric acid = $\frac{1}{2}$ an equiv. of PO_5 or $\frac{1}{4}$ an equiv. of P_2O_5. When mixed with an equal volume of pure sulphuric acid and then added to a solution of sulphate of iron, there is no development of a brown colour, proving the absence of nitric acid (see tests for nitric acid, p. 71). Mixed with an equal volume of solution of perchloride of mercury and heated, no precipitate (metallic mercury) is formed (proving absence of phosphorous acid). Phosphoric acid gives no precipitate with either—1, sulphuretted hydrogen; 2, chloride of barium; 3, nitrate of silver acidulated with nitric acid; or with 4, solution of albumen;—1 and 3 proving the absence of arsenic and other metallic impurities; 2, the absence of sulphuric acid; 3, that of chlorine; and 4, that of metaphosphoric acid, to which the solution of ordinary phosphoric acid is by the loss of 2 eq. of water reduced, if, in the preparation of the acid, too much heat be used. A dull red heat, however, is required for this conversion.

PHOSPHATES.—Neutral solutions of the orthophosphates give, with ammonio-nitrate of silver, a canary yellow precipitate of phosphate of silver, like that produced in a solution of arsenious acid. The solubility of the *phosphate* of silver in ammonia, and in dilute nitric acid, readily distinguishes it from *arsenite* of silver.

Neutral solutions of the orthophosphates also give precipitates with salts of lime and baryta, and with ammonio-sulphate of magnesia a crystalline one (fig. 25), all of which are soluble in mineral and acetic acids. The precipitate ammonio-magnesic or triple phosphate ($MgH_4NPO_4,6H_2O$), formed with solution of ammonio-sulphate of magnesia, is isomorphous with ammonio-magnesic arseniate (see Arseniates). As triple phosphate is insoluble in water containing free ammonia, and is converted into $Mg_2P_2O_7$, or dimagnesic pyrophosphate when ignited, it is a means of estimating the amount of phosphates in solution —100 parts of the ignited salt corresponding to 63·96 of P_2O_5.

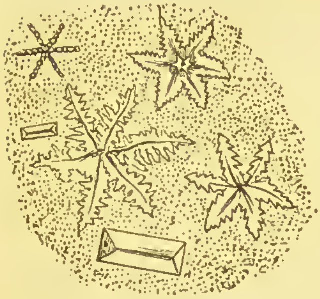

Fig. 25.

Action. Uses.—Phosphoric acid may be given generally as the other mineral acids; it is considered by some to be especially applicable in cases of alkaline urine, and in ossification of the arteries, as it possesses the power of dissolving phosphate of lime. It has been also recommended in Caries and Mollities ossium. It may be employed in the preparation of Refrigerant drinks to allay thirst in Diabetes and febrile affections; but it possesses neither the astringent property of sulphuric nor the alterative powers of nitric acid.

Dose.—10 to 60 minims, diluted with sugar and water.

Incompatibilities.—All substances that are incompatible with other acids.

HYPOPHOSPHOROUS Acid, or *Hydric Hypophosphite*, HPH_2O_2.

This acid is obtained by boiling phosphorus in water with hydrate of baryta. Phosphuretted hydrogen escapes, and hypophosphite of baryta is formed, thus:—$3(BaO,H_2O)+8P+6H_2O=3(Ba2PH_2O_2)+2H_3P$. The baryta may be removed by the cautious addition of sulphuric acid, and a solution of hypophosphorous acid formed. By evaporation, it is obtained in a syrupy form. It is a feeble acid, and by the gradual absorption of oxygen it is converted into phosphoric acid. By heat it is decomposed into phosphuretted hydrogen and phosphoric acid:

$$2HPH_2O_2=H_3P+H_3PO_4.$$

HYPOPHOSPHITES.—These salts are monobasic, soluble in water, and easily crystallisable; but their solutions absorb oxygen at a boiling heat, and the salt is gradually converted into a Phosphite. The crystallised salts undergo no change. The hypophosphites of the metals of the alkalies are anhydrous, deliquescent, and soluble in alcohol.

Hypophosphite of Lime ($Ca2PH_2O_2$), employed in the preparation of Hypophosphite of Soda, is prepared in the same way as the baryta salt, substituting slacked lime for hydrate of baryta.

BORON: B = 11 or **B** = 11.

F. *Bore.* *Borium.* G. *Boron.*

Boron was discovered by Davy in 1807. He obtained it by heating potassium with boracic acid, as a dark olive-coloured powder, devoid of taste and smell, and not acted upon by the usual reagents; heated in the air, it is converted into boracic acid.

BORACIC ACID, *B.P.* ($BO_3 = 34{\cdot}9$ or $\mathbf{B_2O_3} = 69{\cdot}8$). *Acidum Boracicum, Boracic Anhydride.* F. *Acide Boracique.* G. *Borax Säure.*

Boracic acid is so named from borax; from which it may be separated by the action of sulphuric acid. Boracic acid is largely obtained in Tuscany and in the Lipari Isles, where it issues in the steam from fissures in the earth. Circular basins are dug, or the fissures surrounded with cylinders of brickwork, and water is let in, which boils up, from the vapour passing into and through it. The water, having dissolved the acid, is evaporated, and as it cools the acid is deposited in scale-like crystals, which are then dried.

Properties.—Boracic acid is usually seen in transparent scale-like crystals ($\mathbf{HBO_2,H_2O}$), which have a feeble acid taste, and redden litmus slightly, at the same time that they colour turmeric brown, like an alkali. It is sparingly soluble in cold, but requires less than 3 times its weight of boiling water to dissolve it. It is very soluble in alcohol, and gives its flame a green colour. The crystals contain 3 eq. of water of crystallisation, which is expelled by heat; the acid then melts, and on cooling is brittle and glass-like, and may be variously coloured. As the salts of this acid promote the fusion of other bodies, borax is much employed as a blowpipe flux.

Action Uses.—Boracic acid is not officinal, except as a test, and as a constituent of Borax. It was formerly supposed to have some anodyne properties, and was known by the name of *Sal sedativus.* It is used to increase the solubility of cream of tartar.

The *Tartras Borico-potassicus* of the French Codex is formed by dissolving 4 parts of bitartrate of potash and 1 part of crystallised boracic acid in 24 parts of water, and evaporating the solution to dryness. The sour amorphous powder is soluble in water in all proportions. One part of boracic acid and seven of acid tartarate of potash forms the soluble cream of tartar of the shops.

1. **Solution of Boracic Acid.**—Formed by dissolving 50 grains of the acid in 1 fluid ounce of rectified spirit.

Pharmaceutical Uses.—As it colours turmeric brown, and does not affect the colour of rhubarb, it is used as a test of the purity of the latter.

SILICON: Si = 14 or **Si** = 28.

Silicon is a non-metallic element. It is obtained from silica in the same way as boron from boracic acid. It exists as a dark-brown powder; and in crystalline plates of metallic lustre, of sp. gr. 2·49, almost as hard as diamond; very infusible, and not acted upon by any acid but the hydrofluoric.

SILICA or **Silicic Anhydride** ($SiO_2=60$) is the only oxyde; as Sand, Flint, and Quartz, it is an abundant natural production.

THE SILICATES are exemplified in the common natural objects, as Clay, Felspar, Talc, Mica, Asbestos, Meerschaum, French chalk (steatite or soap stone), &c. Most of the silicates are fusible, those of the alkalies only are soluble in water, but when these are combined with the silicates of the earths and metallic oxydes, they are no longer so. These double silicates, in fact, form the different varieties of GLASS. The hard *Bohemian* glass of the laboratory is a mixture of calcic and potassic silicates ($K_2O,3SiO_2.CaO,3SiO_2$), part of the potassium being replaced by sodium, and part of the calcium by magnesium, aluminum, and traces of iron and manganese. *Plate* or window glass consists of sodic and calcic silicates, the hardness and lustre being within certain limits proportionate to the quantity of lime. The bluish-green tinge of this variety is due to the soda. *Flint* glass consists almost wholly of potassic and plumbic silicates, that of English make containing about one-third of its weight of oxyde of lead, which renders it denser, more fusible, and confers a higher refractive and dispersive power. The alkalies, however, corrode it, and the sulphides blacken it. *German and the inferior kinds of English* bottle-glass are free from lead, and consist of a mixture of the silicates of alumina, lime, iron, magnesia, soda, and potash; the olive-green colour of the English variety is due to magnetic oxyde of iron, the brown tinge of German to a mixture of the oxydes of iron and manganese.

Uses.—Washed silver sand or powdered flint (*Silex contritus*, P.L. 1851) and asbestos are useful in several pharmaceutical operations. Powdered steatite is a most grateful and beneficial application in Erythema intertrigo, Eczema, and similar affections of the skin. In the preservation and analysis of chemicals, glass is invaluable. Bohemian glass must be employed in all operations where great heat is employed, and the use of flint glass must be avoided in the preservation of the caustic alkalies and solution of sulphides.

OXYDES OF NITROGEN.—Nitrogen combines with Oxygen in five different proportions, forming compounds, of which Nitric anhydride (Anhydrous nitric acid) is the most important, as containing the greatest quantity of Oxygen.

1. Nitrous oxyde, . .	$NO=22$ or N_2O	$=44$
2. Nitric oxyde, . .	$NO_2=30$ or N_2O_2, or NO	$=30$
3. Nitrous anhydride, .	$NO_3=30$ or N_2O_3	$=76$
4. Peroxyde of nitrogen, .	$NO_4=46$ or N_2O_4, or NO_2	$=46$
5. Nitric anhydride, .	$NO_5=54$ or N_2O_5	$=108$

The first and last of these compounds are employed in medicine, and the others take an important part in many chemical reactions.

NITRIC ACID, *Nitric Hydrate*, $HNO_5=63$ or $HNO_3=68$.

Aqua Fortis. F. *Acide Nitrique.* G. *Saltpetersäure.*

Nitric acid was known to Geber, and probably also to the Hindoos. Cavendish first clearly ascertained its composition by passing electric sparks through atmospheric air over a solution of potash (Phil. Trans. vol. lxxv. p. 572, and vol. lxxviii. p. 261, 1785). It may frequently be detected in the atmosphere after thunderstorms, the oxygen and nitrogen combining together in the path of the electric discharge. In combination with potash, soda, and lime, or ammonia, it is found efflorescent on the soil in some countries (see Nitre); and it is produced thus naturally by the direct combination of oxygen and nitrogen when brought into contact with porous substances containing alkaline or earthy matters. This is proved by the experiments of M. Cloëtz (Acad. Scien. Paris, 1855). He passed air, purified from every trace of ammoniacal and acid vapours, through a number of flasks containing various porous substances (calcined brick dust, carbonate of magnesia, fragments of pumice, &c.) moistened with pure alkaline carbonate. The experiments were conducted at a mean temp. of 51° Fahr., and lasted four months. All the eighteen flasks used, excepting those containing calcined bones and argillaceous earth, contained nitrates. Nitric acid is a constituent of some minerals; and nitrates are invariably present in the juices of vegetables, and in water which has percolated through soil containing animal and nitrogenised vegetable matters.

Preparation.—Nitric acid is prepared by heating together equal weights of *sulphuric acid* and *nitrate of potash* in a glass retort, and collecting the liberated acid by means of a Liebig's condenser. Equal weights of the substances are employed, because they correspond to 1 molec. of nitrate and 2 of acid, and in order to obtain a soluble hydropotassic sulphate, a salt which may be readily washed out of the retort. If less acid were used, insoluble sulphate of potash would be formed. The double decomposition which takes place is represented thus:—$KNO_3+H_2SO_4=HNO_3+KHSO_4$. The acid thus obtained is the Monohydrate (HNO_3) sp. gr. 1·517, at 59°, and contains 85·72 per cent. of anhydrous Nitric acid (N_2O_5). It cannot be distilled without decomposition of a minute portion, and hence it has a ruddy tinge from the presence of some of the lower oxydes of nitrogen. When pure it is colourless. Exposed to the air it absorbs moisture, and ultimately forms a more stable hydrate composed of 2 equivs. of the monohydrate and 3 of water ($2HNO_33H_2O$), having a sp. gr. of 1·424, and containing 60 per cent. of the anhydride (N_2O_5). It may be distilled without decomposition. When a weaker acid is distilled it parts with water until it attains this density; a stronger acid under the same circumstances loses acid, so that in both cases the stable hydrate of sp. gr. 1·424 is obtained. This is the acid of the B.P.; it may be formed by mixing together 70 parts of the monohydrate and 30 parts of water; much heat is evolved in the union. Commercial nitric acid (*Aqua fortis*) is usually weaker than this, the sp. gr. varying from 1·38 to 1·39. The following useful table, showing the percentage of nitric anhydride in acids of various densities, is due to the industry of Ure:—

Specific gravity.	N_2O_5 in 100 parts by weight.	Specific gravity.	N_2O_5 in 100 parts by weight.
1·5000	79·700	1·2887	39·053
1·4940	77·303	1·2705	36·662
1·4850	74·918	1·2523	34·271
1·4760	72·527	1·2341	31·880
1·4670	70·136	1·2148	29·489
1·4570	67·745	1·1958	27·098
1·4460	65·354	1·1770	24·707
1·4346	62·963	1·1587	22·316
1·4228	60·572	1·1403	19·925
1·4107	58·181	1·1227	17·534
1·3978	55·790	1·1051	15·143
1·3833	53·399	1·0878	12·752
1·3681	51·068	1·0708	10·361
1·3529	48·617	1·0540	7·970
1·3376	46·226	1·0375	5·579
1·3216	43·835	1·0212	3·188
1·3056	41·444	1·0053	0·797

Owing to the large quantity of oxygen which it contains, and the facility with which it parts with it, Nitric acid is a powerfully corrosive or oxydising agent. Its action on the metals varies with the temperature and strength of the acid. The monohydrate is without action on iron and other metals. When diluted to sp. gr. from 1·35 to 1·25 its action is most energetic, and the presence of nitrous acid, owing to its instability, greatly increases the oxydising power of nitric acid. The action of nitric acid on the metals may be thus illustrated. Silver and palladium with the cold acid give nitrates, water, and nitrous acid, thus:—$Ag_2 + 3HNO_3 = 2AgNO_3 + H_2O + HNO_2$. Copper and mercury extract 2 atoms of oxygen, converting a portion of the nitric acid into nitric oxide, thus:—$3Cu + 8HNO_3 = 3(Cu2NO_3) + 4H_2O + 2NO$. With a stronger acid (sp. gr. 1·42) ruddy fumes of peroxide of nitrogen are freely evolved, thus:—$Cu + 4HNO_3 = Cu2NO_3 + 2H_2O + 2NO_2$; and at a higher temperature the acid undergoes complete oxydation, and free nitrogen is evolved, thus:—$5Cu + 12HNO_3 = 5(Cu2NO_3) + 6H_2O + N_2$. With more oxydisable zinc the more dilute acid yields nitrous acid:—$4Zn + 10HNO_3 = 4(Zn2NO_3) + 5H_2O + N_2O$. When a stronger acid is used, ammonia is formed, thus:—$4Zn + 9HNO_3 = 4(Zn2NO_3) + 3H_2O + H_3N$. Water, it is to be observed, is formed in each of these decompositions, the hydrogen of the acid being replaced by the metals.

Other substances, as charcoal, phosphorus, alcohol, starch, and sugar, also deprive nitric acid of its oxygen. It stains the skin and its appendages yellow by the conversion of the albuminous constituent into xanthoproteic acid, and gives a deep red colour with either brucia or morphia.

Impurities.—These are sulphuric acid, chlorine, the lower oxydes of nitrogen, soda, potash, and iron. The iron is derived from the iron retorts in which the commercial acid is prepared; the other impurities are derived from the articles employed in the manufacture, and from the effect of heat on the acid itself. Evaporated on a slip of glass nitric acid should leave no residue (absence of fixed salts). Diluted with water, it should give no precipitate with either baric or argentic nitrate (absence of sulphuric acid and chlorine or chloride). The Nitrate of soda from Chili contains iodine. Nitric acid prepared from this is at first brown from the presence of iodine (which may then be detected by starch), but after a time it becomes colourless from the oxydation of the iodine into iodic acid. (Pereira.) A pure acid may be obtained from one containing all these impurities by diluting it if necessary to sp. gr. 1·42, or below, and distilling with a little nitrate of silver and 2 or 3 per cent. of potassic dichromate. The nitrate fixes the chlorine or iodine, and the chromate removes the lower oxydes, while the sulphuric acid and salts remain in the retort.

Incompatibles.—Alkalies and oxydes generally. Carbonates, acetates, sulphides, sulphate of iron.

Antidotes.—Magnesia, Chalk, Lime water, Whiting; Bicarbonates of the alkalies; Soap.

1. **Acidum Nitricum,** *P.B.*—This is the stable sesquihydrate ($2HNO_3,3H_2O$). It is defined as an acid prepared from nitrate of potash or nitrate of soda by distillation with sulphuric acid and water, and containing 70 per cent. by weight of nitric acid, $HONO_5$ or HNO_3, corresponding to 60 per cent. of anhydrous nitric acid, NO_5 or N_2O_5.

Characters and Tests.—Colourless, sp. gr. 1·42: emitting an acrid corrosive vapour. Boiling point, 250°. It distils unchanged. Poured upon copper filings, dense red fumes (peroxyde of nitrogen) are immediately formed; but when previously diluted with an equal volume of water, only a colourless gas (nitric oxyde), which becomes orange-red (peroxyde) as it mixes with the air (see p. 55); and which if it be conveyed into a solution of sulphate of iron gives it a dark purple or brown colour (see Nitrates, p. 72). The acid leaves no residue when evaporated to dryness. Diluted with six volumes of distilled water, it gives no precipitate with chloride of barium or nitrate of silver. 90 grains, mixed with half an ounce of water, require for neutralisation 1000 grain measures of the volumetric solution of soda.

Action. Uses.—Nitric acid undiluted is a powerful caustic, and as such is applied by means of a glass-rod or pipette to Warts.

Hæmorrhoids, Phagedenic ulcers, Gangrene of the mouth, sloughing Chancres, Poisoned bites.

Pharmaceutical Uses. — The preparation of Acidum nitricum dilutum, Acidum nitro-hydrochloricum, Liquor Ferri pernitratis, Liquor Hydrargyri nitratis acidus, Unguentum Hydrargyri nitratis.

2. **Acidum Nitricum dilutum,** *P.B.* *Diluted Nitric Acid.*

Preparation.—Dilute 6 fluid ounces of *Nitric acid* with 24 ounces of *water*, then add more water, so that at a temperature of 60° it shall measure 31 fluid ounces. Or as follows:—Weigh 2400 grains of Nitric acid in a glass flask the capacity of which, to mark on the neck, is one pint, then add distilled water until the mixture, at 60°, measures a pint, after it has been shaken.

Characters and Tests.—Sp. gr. 1·101. 6 fluid drachms = 361·3 grains are neutralised by 1000 gr. meas. of the volumetric sol. of soda, corresponding to 54 grains of anhydrous nitric acid (one equiv. of NO_5, or half an equiv. N_2O_5) or 14·95 per cent.

Action and Uses.—Tonic, antalkaline, and resolvent. It is destitute of astringent properties.

It is beneficial in all varieties of lithiasis, removing the alkalinity which is usually associated with the phosphatic diathesis; while in oxaluria and in the uric acid diathesis it appears to relieve (probably by yielding oxygen to the blood) that depression of the oxydising processes of which these conditions are the result. It is useful in atonic dyspepsia, in chronic hepatic diseases, in syphilitic cachexia, and generally in debility of the muscular and nervous tissues, but especially when associated with a tendency to fatty degeneration. It may be given with quinine, strychnia, and the bitter infusions.

Dose.—10 to 30 minims, suitably diluted. It should be drunk through a quill or glass tube.

Nitrates.—Nitric acid is monobasic; no acid nitrates exist, and only a few basic ones, of which subnitrate of bismuth is an example. Most of the nitrates (*e.g.*, that of silver) fuse when heated, and at a high temperature they are decomposed. Those of potash and soda give off pure oxygen, and are converted into nitrites; others, such as copper, evolve a mixture of oxygen and nitrogen, and are converted into pure oxydes. Thrown upon glowing coals, the nitrates are decomposed with scintillation; and the same occurs with "touch paper" (paper moistened with a nitrate, and dried), the liberated oxygen maintaining the smouldering combustion. As the nitrates are all soluble, it is impossible to estimate nitric acid by precipitation. Its presence or that of a nitrate may, however, be readily indicated. If the acid be free, neutralise with potash; the resulting nitrate, in common with all other nitrates, evolves nitric acid when heated with sulphuric acid, and we have only to bring in contact with the liberated acid a fragment of copper, or a little solution of protosulphate of iron, to demonstrate the presence of one of the lower oxydes of nitrogen derived by decomposition from the nitric acid. The formation of peroxyde of nitrogen by the action of copper has been already explained (p. 70). In the iron test, the protosalt is in part converted into persalt by the deoxydation of the nitric acid into nitric oxyde, which dissolves in the undecomposed part of the solution, and gives the characteristic brown colour. The decomposition is thus represented:—

$$6FeSO_4 + 3H_2SO_4 + 2HNO_3 = 3(Fe_2 3SO_4) + 4H_2O + 6NO.$$

The addition of a few drops of hydrochloric acid to a solution containing nitric acid, free or combined, confers the power of dissolving gold leaf. (See Nitrohydrochloric acid). Of itself, however, this is not distinctive of the presence of nitric acid; for the chlorates, bromates, and iodates mixed with hydrochloric acid have the same power. These salts, however, may be readily known from the nitrates.

The following are the nitrates of the P.B.:—Argenti nitras, Bismuthi subnitratis, Ferri pernitras (Liquor), Hydrargyri nitras (Liquor acidus), Plumbi nitras, Potassæ nitras, Sodæ nitras.

NITROUS OXYDE: $NO = 22$ or $N_2O = 44$.

Protoxyde of Nitrogen or *Laughing Gas.*

Preparation.—Introduce a sufficient quantity (1 pound) of anhydrous nitrate of ammonia into a stoppered retort, apply heat (230°) by means of a sandbath, and thus fuse the salt. Then increase the heat, always keeping it below 485°. At about 356° the salt boils, and between 460° and 480° is decomposed into steam and nitrous oxyde, $NH_4NO_3 = 2H_2O + N_2O$, the latter escapes with effervescence. A free and equable, but not tumultuous liberation of gas, should be maintained by a cautious regulation of temperature. Pass the gas through two deep wash-bottles, one containing half a pint of water, and the other a pint of water to which a fluid ounce of solution of potash has been added, and finally conduct the gas into a suitable gas holder over water, in which it may be stored for some weeks. As water takes up more than $\frac{2}{3}$ of its bulk of gas at 60°, it will at first be necessary to repeat the operation, when there will be no loss of gas. It is desirable that the gas should stand over water a few hours before it is inhaled. The water in the gas holder will seldom require changing oftener than once in six months. When the nitrate contains water of crystallisation, the gas is disengaged less equably, and if the temperature be allowed to rise above 500° a little nitric oxyde is liable to be formed. Hence the precaution of washing with caustic potash.

Characters and Tests.—A colourless gas, sp. gr. 1·527, having a faint sweetish taste, and very faint agreeable odour; liquefied at 45° by a pressure of 50 atmospheres. 100 vols. of water at 32° dissolve 130 vols. of the gas; 77 vols. at 59°; and 60 vols. at 75°. It supports combustion almost as well as oxygen, a glowing match bursting into flame when immersed in it. A stream of the gas directed on a piece of moistened blue litmus paper does not affect the colour, showing the absence of the acid oxydes of nitrogen.

Action and Uses.—Nitrous oxyde agrees closely with oxygen in its action, first producing cardiac stimulation and then asphyxia. The stimulant action is best seen when the gas is mixed with air, as when the lungs have not been sufficiently cleared of it by a forced expiration before inhalation of the gas; in this case the patient becomes excited and restless, sometimes violent, and sometimes affected with incontrollable laughter. But when the gas is inhaled undiluted, these effects are rarer, and although there is commonly some evidence of brief excitement, the patient becomes unconscious in from half a minute to three minutes from the commencement of inhalation. In this condition there is stagnation of the capillary circulation, and as a consequence increased pressure in the arteries, and lividity of the face. The stimulant effect must not, I think, be regarded as a direct effect of the gas on the heart, but as the consequence of commencing and rapidly increasing stagnation (asphyxia) of the blood in the pulmonary capillaries—an impediment which the heart is at once called upon to remove. Oxygen and nitrous oxyde both cause asphyxia, by disturbing the proper proportions of the gases of the blood, and the action of the latter is more rapid in proportion to its greater solubility in the blood. According to MM. Jolyet and Blanch, the asphyxia is not due to the presence of so large a quantity as 34·6 per cent. of its volume of nitrous oxyde in the blood, but to the exclusion and diminution of oxygen (*Archives de Physiologie*, 1873).

The state of unconsciousness is, of course, attended by and is co-extensive with that of anæsthesia. The duration of this rarely exceeds a minute, an interval of time sufficient for the performance of such an operation as the extraction of a tooth. The gas should be inhaled by means of a suitable mouth-piece, from an India-rubber bag capable of holding 8 or 10 gallons. The mouth-piece is provided with two valves, arranged so as to allow of the free exit of expired air, and to prevent the inspiration of atmospheric air. A prolonged forcible expiration should be made before the inhaler is placed on the mouth. If the inhalation be too prolonged, the heart's action is arrested from over-venous distension; when this occurs a jugular vein should be opened, and artificial respiration employed.

Nitrous Oxyde Water.—A solution, effected under pressure, of 4 or 5 volumes of the gas in water, has been proposed as a stimulant, under the name of *Aqua nitrogenii protoxydi.*

IODINE: I=127 or **I**=127. Comb. vol. of vapour, 1.

Iodinium. *Iodum, P.B.* F. *Iode.* G. *Iod.*

Iodine, from ἰοειδὴς, *violet-coloured*, which distinguishes its vapour, was obtained by Courtois in 1812 in the residual liquor of the process for obtaining soda from Kelp. Though so lately discovered, its effects have long been obtained in medicine, as it is found in sea and several mineral waters, and in sea-weeds, sponge, corals, and some molluscous animals. In the present day, the leaf of a sea-weed (a species of *Laminaria*) is employed in the Himalayas, and called the *goître-leaf*, and in S. America the stems of a sea-weed are sold by the name of *goître-sticks*, because they are chewed by the inhabitants wherever goître is prevalent.* Burnt sponge has been long a popular remedy for the same disease in this country.

Extraction.—Iodine is obtained from the ashes of sea-weeds, called kelp, and is largely prepared at Glasgow. Graham states, that the long elastic stems of *Fucus palmatus* afford most of the iodine contained in kelp; and as this is a deep-sea plant, it is found most on exposed sea coasts. Dr Traill says, that the greatest quantity is produced by kelp made from "drift-weed," which is in a great measure composed of *Fucus digitatus* and *F. Loreus;* and that "cut weed," which consists of *F. vesiculosus* and *F. serratus*, yields much less of it. It is also yielded in very large proportion by certain species of *Laminaria*, especially the common *L. digitata.* According to the experience of a manufacturer, 100 tons of Caithness kelp yield 1000 pounds of iodine, or about a 224th part.

The dried sea-weed is burnt in shallow excavations in the ground, at a low heat, to avoid dissipation of the sodic iodide. The half-fused ash (*kelp*) is powdered, and exhausted with boiling water. The solution is evaporated to a small bulk, and the sulphates and carbonates removed by crystallisation. Disodic sulphide, sodic carbonate, and hyposulphite, with the sodic iodide, remain in the dark brown mother liquor or *Iodine ley*, which having attained a sp. gr. of 1·35 is mixed with one-eighth of its bulk of sulphuric acid, and allowed to stand for twenty-four hours. Carbonic anhydride, sulphurous anhydride, and sulphide of hydrogen gases escape, and sodic sulphate and sulphur separate. These are removed, and the acid liquid which retains all the sodic iodide is heated in a retort to 140°, when powdered black oxide of manganese is added. The iodine is now liberated, and distils at a low temperature, and is collected in suitable reservoirs, sodic and manganous sulphate remaining in the retort. The following formula represents the decomposition:—

$$2NaI + MnO_2 + 3H_2SO_4 = 2NaHSO_4 + MnSO_4 + 2H_2O + 2I.$$

If the temperature rise as high as 212°, chlorine is evolved from the sodic chloride retained in the iodine liquor, and combines with the iodine. This must be carefully avoided.

Iodum, *P.B.* *Iodine.* A non-metallic element, obtained principally from the ashes of sea-weeds as above described.

Characters and Tests.—In soft laminar crystals, of a weak chlorinous odour, bluish black, with a metallic lustre, crumbling when rubbed between the thumb and fingers, and staining the cuticle dark yellowish brown. Sp. gr. 4·94; when heated fusing at 225°, boiling at 348°, and yielding a beautiful violet-coloured vapour, sp. gr. 8·71.

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* *Vide* Royle's Illustr. of Himalayan Botany, p. 441.

Very sparingly soluble in water (1 part in 7000), but freely soluble in alcohol, æther, and solution of iodide of potassium. The aqueous solution strikes a deep blue colour with starch. It sublimes without leaving any residue; and the portion that first comes over does not include any slender colourless prisms emitting a pungent odour, (CyI). A little cyanide is liable to be formed during the combustion of the sea-weed by the mutual action of the organic matter of minute marine animals attached to the sea-weed, and the alkaline salts at a high temperature (see p. 100); and this is decomposed when the iodine is liberated, and unites with it. 12·7 grains dissolved in an ounce of water containing 15 grains of iodide of potassium, require for complete decoloration 1000 gr. meas. of the volumetric solution of hyposulphite of soda (which see for the explanation of this reaction). It evaporates at ordinary temperatures, and is deposited in the upper part of the bottle in which it is contained in brilliant rhombic based octohedrons.

Impurities.—Iodine is said to be sometimes adulterated with charcoal, plumbago, black oxyde of manganese, and sulphide of antimony. All but the last remain after sublimation; the black antimony is insoluble in æther; but its chief impurity is moisture, of which it sometimes contains as much as 15 or 20 per cent., when it looks wet, and sticks to the sides of the bottle. It should be entirely soluble in æther.

Iodine combines directly with some of the metals, *e.g.*, iron and zinc, which disappear when placed in water with iodine, iodides of the metals being formed. Iodine imbues starch with an intense blue colour, the production of which is a decisive indication of the presence of either substance. This test is also so very delicate that the blue colour is produced when starch is added to a solution of one part of iodine in a million parts of water. The test may be applied in various ways: A few starch granules may be thrown into the fluid suspected to contain iodine, and when they have settled to the bottom of the vessel, they may be removed with a pipette and examined under the microscope. If there be much free iodine present, the starch granules are dyed the deepest indigo. If an aqueous solution of starch be used, a brilliant blue is immediately developed when the fluid contains only a trace of iodine. Paper smeared with starch and dried, is conveniently preserved as a test for iodine. The blue colour is only developed in the presence of *free* iodine; it disappears on heating the mixture, but partially returns as it cools. The alkalies, sulphurous acid, and sulphide of hydrogen also remove the colour.

Action. Uses.—The extensive use in medicine of iodine and its compounds was first brought about by the discovery, made not long ago, that this substance was the active ingredient of burnt sponge, a remedy long used in goître. Given internally, iodine, free or in combination, passes into the blood, and thence into all the fluids of the body, including the milk and the sweat. It tends after a time to impoverish the blood, and in this manner may lead to atrophy of the solid tissues. Its prolonged and injudicious use is said to have caused absorption of the mammæ and the testicles. When contained in blood, it appears to excite the glandular system generally to unusual activity, especially the salivary glands, the liver, and the kidneys. Its beneficial action in morbid conditions of these organs is doubtless due to this functional excitement, under the influence of which morbid deposits are removed, or prevented. It has a powerful curative action in two classes of disease, namely, syphilis and scrofula. In the former disease, its influence is most marked in the secondary and tertiary forms. In Scrofula, the remedy may be simultaneously used internally and externally, iodide of potassium or iron being given by the mouth, while the Liquor iodi is applied to the enlarged glands or swollen joints. As a result of the stimulant action on the glands, and of the readiness with which iodine combines with the metals, it is a valuable remedy in metallic poisoning, promoting the elimination of the metal from the body. Iodine may be used as a diuretic in dropsies. Unless it is required to stimulate the mucous membrane of the gullet and stomach, or to employ iodine as a disinfectant of these parts, free iodine should never be given internally, since it possesses no other advantage over iodide of potassium, which is more readily absorbed. And this remark is equally applicable to the external use of iodine, iodide of potassium being much more readily absorbed than free iodine. Indeed, strong solutions of iodine, such as the Linimentum iodi, cause so much irritation of the skin, amounting in delicate persons to fine vesication, that little or no iodine is absorbed. What benefit results must be attributed more to the effects of common irritation than to a specific action on the part derived by absorption. If it be wished to secure absorption, a solution not stronger than the tincture should be used. Iodine is very useful in preventing putrescent decomposition within cystic tumours, and in promoting their suppuration. An injection for this purpose may be made by the addition of 2 fl. drs. of the tincture to a pint of water. The cyst may be freely washed out with a pint or more of this fluid (see "Treatment of Hydatid Cysts of the Liver," by the Editor, Med. Chir. Trans. vol. xlix.) In order to promote adhesive inflammation between the surfaces of serous membranes, as in the radical cure of Hydrocele, the solution should be ten times stronger. After it has been in contact with the walls of the cyst for ten minutes, it should be allowed to return through the canula. Such strong solutions are violently irritant, and the greatest care must be taken to prevent their introduction into the healthy serous cavities or the areolar tissue.

Iodism, or the symptoms which result from saturation of the system with Iodine, or from great susceptibility of its action, are the following:—A disagreeable taste of iodine with slight ptyalism, aching of the teeth and jaws, tenderness and sometimes pain in the periosteum and eyeballs, catarrh, coryza, rarely slight conjunctivitis, and in extreme cases the eruption of a bright papular rush upon any part of the body, and a strong odour of iodine from the exhalations of the body. Swelling of the gums, diuresis, and a tendency to diarrhœa, may occur, if the earlier symptoms of iodism are overlooked, and the use of the drug continued.

Dose.—As Tincture, gr. $\frac{1}{4}$ to $1\frac{1}{2}$, largely diluted.

Antidotes.—Lime water. Large draughts of solution of Starch, both before and after evacuating the stomach.

Pharmaceutical Uses.—In the preparation of the following; and of Iodides of cadmium (Unguenti cadmii iodidi); iron (Syrupus ferri iodidi, Pilula ferri iodidi); mercury, red and green (Unguenti hydrargyri iodidi rubri); lead (Ung. plumbi iodidi).

IODIDES are decomposed by chlorine, bromine, and nitric acid, the iodine being set free. Hence the presence of an iodide may be readily detected. First add a little chlorine water (or chloride of lime or soda), or nitric acid, and then a slip of starch paper. The other characters of an iodide are well illustrated in Iodide of potassium (see p. 80).

1. **Liquor Iodi,** *P.B. Solution of Iodine.*

Preparation.—Mix together 20 grains of *iodine*, 30 grains of *iodide of potassium*, and 1 fluid ounce of *water*, and dissolve.

24 minims contain 1 gr. of iodine, and $1\frac{1}{2}$ gr. of iodide of potassium. It is not so irritant as the liniment.

Dose.—Internally, 5 to 10 minims.

2. **Tinctura Iodi,** *P.B. Tincture of Iodine.*

Preparation.—Dissolve $\frac{1}{2}$ ounce of *iodine* and $\frac{1}{4}$ ounce of *iodide of potassium* in 1 pint of *rectified spirit.*

40 minims contain 1 grain of iodine and $\frac{1}{2}$ grain of iodide of potassium. The best form for internal exhibition. The iodide increases the solubility of the iodine, and renders the tincture miscible with water. It may be given with water or sherry.

Dose.—10, gradually increased to 30 minims.

3. **Vapor Iodi,** *P.B. Vapour of Iodine for Inhalation.*

Preparation.—Mix together, in a suitable apparatus, 1 fluid drachm of *tincture of iodine* and 1 fluid ounce of *water*, and, having applied a gentle heat, let the vapour that arises be inhaled. A more convenient and efficacious process is to paint the tincture upon the chest of the patient, or to place a little piece of flannel saturated with it upon a hot-water bottle in the bed, and direct the patient to keep his head under the bed-clothes for a few minutes at a time.

Iodine vapour is of use in chronic, especially syphilitic, Laryngitis. It may also be employed in gangrene of the lung and in chronic Phthisis.

4. **Unguentum Iodi,** *P.B. Ointment of Iodine.*

Preparation.—Rub 32 grains each of *iodine* and *iodide of potassium* well together with 1 fluid drachm of *proof spirit* in a glass or porcelain mortar, add 2 ounces of *prepared lard* gradually, and mix thoroughly.

Action. Uses.—Employed as an external application in Bronchocele, scrofulous enlargements, and chronic tumours generally.

5. **Linimentum Iodi,** *P.B. Liniment of Iodine.* (*Iodine Paint.*)

Preparation.—Dissolve $1\frac{1}{4}$ ounce of *iodine*, $\frac{1}{2}$ ounce of *iodide of potassium*, and $\frac{1}{4}$ ounce of *camphor* together in 10 fluid ounces of *rectified spirit.*

This contains $\frac{1}{8}$ part of Iodine, and is very different from the tincture, which contains only $\frac{1}{40}$. The tincture is intended for internal use. This liniment is a substitute for Lugol's tincture, and is adapted for external use as an escharotic for the dispersion of scrofulous and other tumours. (Solutions of iodine in glycerine have been used by some practitioners. They have the advantage of not drying, so that the absorption of the iodine goes on without hindrance.)

6. **Volumetric Solution of Iodine,** *P.B.*—1000 gr. measures contain 12·7 grains of iodine.

Preparation.—Put 127 grains of *iodine* and 180 grains of *iodide of potassium* into the 10,000 grain flask; add sufficient *water*, and agitate gently until solution is complete; and then dilute the fluid with more water until it measures exactly 10,000 gr. measures. 1000 gr. measures contain $\frac{1}{10}$th of an equivalent in grains (12·7 grs.) of iodine, and therefore correspond to 1·7 gr. of sulphuretted hydrogen, 3·2 grs. of sulphurous, and 4·95 grs. of arsenious acid. Grammes and cubic centimetres may be used instead of grains and gr. measures; but for convenience, $\frac{1}{10}$th of the numbers should be taken. 100 cubic centimetres contain 1·27 gramme of iodine, and correspond to 0·17 gramme of sulphuretted hydrogen, 0·32 gramme of sulphurous, and 0·495 gramme of arsenious acid.

Uses.—For testing the following. In each case oxydation occurs, hydriodic acid is formed, and the colour continues to be discharged from the solution until this is complete. The solution is dropped from the burette into the liquid to be tested until iodine begins to appear in the solution.

	Grs.	Gr. meas.	Grm.	Cub. centim.
Acidum arseniosum, . .	4·0 =	808, or	0·40 =	80·8
„ sulphurosum, . .	34·7 =	1000, or	3·47 =	100·0
Liquor arsenicalis, . .	441·5 =	808, or	44·15 =	80·8
„ arsenici hydrochloricus,	441·5 =	810. or	44·15 =	81·0

The following are the reactions which occur. In the first case, $2I_2 + As_2O_3 + 5H_2O = 2H_3AsO_4 + 4HI$, the arsenious acid being oxydised to arsenic acid.

In the second, $I_2 + SO_2 + 2H_2O = H_2SO_4 + 2HI$, the sulphurous acid being oxydised to sulphuric.

In the third and fourth cases, the arsenious acid in the solutions is converted as in the first case.

AMMONII IODIDI: $H_4NI = 145$ or $H_4NI = 145$.

Iodide of Ammonium may be prepared in the same manner as the bromide, substituting iodine for bromine. Or, a solution of carbonate of ammonia may be added to one of proto-iodide of iron so long as a precipitate is formed: on evaporating the filtered solution on a water bath, crystals like those of sal-ammoniac are formed.

Characters and Tests.—Very soluble in water. On exposure to the air, the salt becomes a little yellow from liberation of iodine. Heated with potash, ammonia is evolved. An aqueous solution mixed with a few drops of solution of chlorine, renders starch blue.

Action and Uses.—Those of iodide of potassium.

Dose.—2 to 10 grains.

POTASSII IODIDUM, *P.B.* KI = 166 or **KI** = 166.

Hydriodate of Potash. F. *Iodure de Potassium.* G. *Iod Kalium.*

Iodide of potassium contains in 100 parts 76·44 of iodine and 23·56 of potassium. It exists in sea as well as in some mineral waters, in sea-weeds and sponges. It was first employed in medicine by Coindet.

Preparation.—Place a gallon of *solution of potash* in a glass or porcelain vessel, and add 29 ounces of *iodine*, or a sufficiency, in small quantities at a time, with constant stirring, until the solution acquires a permanent brown tint. Evaporate the whole to dryness in a porcelain dish, pulverise the residue, and mix it intimately with 3 ounces of wood *charcoal* in fine powder. Throw the mixture, in small quantities at a time, into a red-hot iron crucible, and, when the whole has been brought to a state of fusion, remove the crucible from the fire, and pour out its contents. When the fused mass has cooled, dissolve it in 2 pints of boiling water, filter, and evaporate till a film forms on the surface, then set the liquid aside to cool and crystallise. Drain the crystals, and dry them quickly with a gentle heat. Evaporate the mother liquor, and get another crop of crystals. Preserve the salt in a stoppered bottle.

When Iodine is added to solution of caustic potash, it dissolves and forms a colourless solution of iodide and iodate of potash, thus:

$$6I + 6KHO = 5KI + KIO_3 + 3H_2O,$$

6 equivs. of iodine converting 6 equivs. of potash into 5 of iodide of potassium, and 1 of iodate of potash with the formation of 3 equivs. of water. Now, iodine is freely soluble in iodide of potassium, forming a deep reddish brown solution, and a mere trace of Iodine in excess gives a yellowish brown tint, and it is directed that this brown tinge be produced in order that no free potash may remain in the solution. By fusing the mixed salts with charcoal, the iodate is deoxydised by the latter and converted into iodide, the carbonic oxyde which is formed escapes from the mass, and only Iodide of Potassium remains: $KIO_3 + 3C = KI + 3CO$. At a higher temperature the iodide volatilises unchanged.

Characters and Tests.—In colourless, generally opaque, cubic crystals, of a bitterish and acrid saline taste, not deliquescent (absence of carbonate of potash) in dry air, readily soluble in water (in $\frac{2}{3}$ of its weight), and in a less degree in alcohol (in 6 times its weight of alcohol, sp. gr. 0·83). It commonly has a feebly alkaline reaction; the solution mixed with mucilage of starch gives a blue colour on the addition of a minute quantity of solution of chlorine (indicating the presence of iodine). It gives a crystalline precipitate (acid tartrate of potash) with tartaric acid (presence of potassium). The addition of tartaric acid and mucilage of starch to its watery solution does not develop a blue colour (this proves the absence of iodate; tartaric acid liberates from the iodide hydriodic acid HI, which has no action on starch; but if iodate be present, it also liberates iodic acid HIO_3, which immediately reacts on the hydriodic acid, setting iodine free to combine with the starch: $5HI + HIO_3 = 6I + 3H_2O$).

Solution of nitrate of silver, added in excess, forms a yellowish white precipitate (AgI, insoluble in ammonia), which when agitated with ammonia yields by subsidence a clear liquid, in which excess of nitric acid causes no turbidity (proving the absence of chlorides; chloride of silver is soluble in ammonia, and would be precipitated from solution in it when supersaturated with nitric acid, causing a turbidity); aqueous solution of iodide of potassium is only faintly precipitated by the addition of saccharated solution of lime (indicating a trace of carbonate). It is a solvent for iodine and the insoluble iodides.

Impurities.—Since the chlorides, bromides, and iodides of the alkaline metals are all colourless, and crystallise in regular cubes which are indistinguishable from each other, it follows that, if the iodide be fraudulently adulterated, we may expect to find some common salt, or either chloride or bromide of potassium. The chlorides are detected by the process given above. Admixture with a bromide may be thus detected:—Add to a solution of the suspected iodide a solution of 1 part of cupric sulphate and 2¼ parts of sulphate of iron; the whole of the iodine is thrown down as iodide of copper (Cu_2I_2), but the bromide remains in solution, and may be detected by adding a solution of chlorine to disengage the bromine, and then æther, which abstracts it from the water, and forms a hyacinth-red solution ("Bentley and Redwood's Pereira," p. 147).

Iodide of Potassium is anhydrous; but the crystals often decrepitate slightly when heated, and this is due to the retention of a little water in their interstices. When fused, the dry salt should not lose weight.

Iodide of Potassium is remarkably free from adulteration; and the commonest impurity is iodate of potash, due to carelessness, or even omission of the last part of the process. When this impurity exists, solution of the salt gives, when mixed with an ordinary acid solution of quinine, a brown precipitate.

Incompatibilities.—Iodide of potassium may be taken as the type of the iodides (see p. 78). It is incompatible with chlorine, bromine, and strong nitric acid in the cold. Dilute nitric and sulphuric acids, when warmed with an aqueous solution, also set free iodine. The dilute mineral acids and stronger vegetable acids liberate hydriodic acid in cold solutions. Corrosive sublimate occasions a brilliant scarlet precipitate (red iodide of mercury) soluble in excess of the iodide. Neutral nitrate of mercury and calomel both form green iodide of mercury. Acetate of lead gives a yellow precipitate of iodide of lead. Perchloride of platinum forms a reddish brown solution of PtI_4.

Action.—This is identical with that of Iodine (see p. 76), excepting only that it has no local irritant action. Iodide of potassium is so completely destitute of irritant properties, that a moderately strong solution (5 grs. in 1 fl. dr.) does not cause the slightest irritation when dropped into the eye. A leech immersed in the same solution will die in the course of an hour or so. No salt is more rapidly absorbed and eliminated than KI. Within a few minutes of its injection into the stomach, and within less than a minute from the time of its injection into the areolar tissue, it may be detected by means of the starch test in any of the secretions of the body. One of the most valuable properties of the iodide is its power of setting Lead and Mercury free from their combination with the tissues, forming iodides with them, holding them in solution, and carrying them out of the body. The first few doses of iodide sometimes produce rather severe catarrhal symptoms; but these disappear in the course of a day or two under the continuance of the drug. In some persons,—and those whom I have known to possess this idiosyncrasy have taken mercury for venereal disease some years previously,—5 grains of iodide of potassium will induce profuse ptyalism, and they are totally unable to continue the medicine. This effect is supposed to be due to the liberation of mercury which has long lain dormant in the body.

Medicinal Uses.—Those of iodine, above indicated. In syphilitic periostitis and neuralgia it is specific. In rheumatic ostitis and periostitis it is very serviceable. In mercurial and lead poisoning it is the appropriate remedy. It often promotes absorption in ascites, and is generally beneficial in this condition on account of its diuretic action. As a parasiticide I have found it useful in the treatment of Bilharzia; and when the entozoon is located in the bladder, 15 or 20 grains dissolved in 3 or 4 ounces of water may be injected into the bladder. It may be used in the same way against Ascarides.

Dose 2 to 10 grains. In some cases it is necessary to increase the dose largely. In syphilitic paraplegia I have occasionally given 60 grains daily for a fortnight without any inconvenience.

Antidotes.—Evacuate the stomach; give Demulcents; obviate Inflammation, and allay Irritation.

Pharmaceutical Uses.—In the preparation of the following seven articles:

1. **Solution of Iodide of Potassium.** 1 ounce of the salt dissolved in 10 ounces of water is used as a test of the presence of mercury and lead.

2. **Unguentum Potassii Iodidi**, *P.B. Ointment of Iodide of Potassium.*

Preparation.—Dissolve 64 grains of *iodide of potassium* and 4 grains of *carbonate of potash* in 1 fluid drachm of *water*, and mix with 1 ounce of *prepared lard.*

This ointment is colourless, and as it neither stains nor irritates the skin, it is adapted for use in Bronchocele and other tumours on exposed parts of the body. It contains a small quantity of soap, formed by the potash.

3. **Linimentum Potassii Iodidi cum Sapone**, *P.B. Liniment of Iodide of Potassium and Soap.*

Preparation.—Dissolve 1½ ounce of *hard soap*, cut small, in 7 fluid ounces of *water* by the heat of a water-bath. Dissolve ½ ounce of *iodide of potassium* and 1 ounce of *glycerine* in the remainder of the water, and mix the two solutions together. When the mixture is cold add 1 fluid drachm of *oil of lemon*, and mix the whole thoroughly.

This is also a colourless application, employed, as the last, to reduce glandular swellings and local inflammations.

4. **Liquor Iodi**, *P.B.*; 5. **Tinctura Iodi**, *P.B.*; 6. **Unguentum Iodi**, *P.B.*; 7. **Linimentum Iodi**, *P.B.*; all of which are described under IODINE, p.

Emplastrum Potassii Iodidi. *Plaster of Iodide of Potassium.*

Preparation.—To 6 ounces of prepared *frankincense*, melted with 6 drachms of *wax*, add 1 ounce of *iodide potassium*, first triturated with 2 fluid drachms of *olive oil*, and stir constantly until they cool.

This plaster should be spread on linen.

Use.—A good application to chronic glandular swellings, or scrofulous tumours. Omitted in the present Pharmacopœia.

SULPHURIS IODIDUM, *P.B.* *Iodide of Sulphur.*

Preparation.—Rub 4 ounces of *iodine* and 1 ounce of *sublimed sulphur* together in a Wedgwood mortar until they are thoroughly mixed. Put the mixture into a flask, close the orifice loosely, and apply a gentle heat, so that the colour of the mass shall become gradually darkened. When the colour has become uniformly dark throughout, increase the heat so as to produce liquefaction. Then incline the flask in different directions, in order to return into the liquid any portion of the iodine which may have been condensed on the inner surface of the vessel. Lastly, withdraw the heat, and when the liquid has congealed, remove the mass by breaking the flask, reduce it to pieces, and keep these in a well-stoppered bottle.

A sub-iodide (S_2I_2) is produced by this process.

Characters and Tests.—A greyish black solid substance, with a radiated crystalline appearance. It resembles iodine in smell, and in the property of staining the cuticle when applied to it. Soluble in about 60 parts of glycerine; insoluble in water, but decomposed when boiled with it. If 100 grains be thoroughly boiled with water the iodine will pass off in vapour and about 20 grains of sulphur will remain.

Action. Uses. Chiefly used externally, as in the following ointment.

1. **Unguentum Sulphuris Iodidi,** *B.P. Ointment of Iodide of Sulphur.*

Preparation.—Triturate 30 grains of *iodide of sulphur* in a porcelain mortar, and gradually add 1 ounce of *prepared lard*, rubbing them together until the ointment is perfectly smooth.

Used in skin diseases, especially those of a scrofulous character.

BROMINE: $Br=80$ or $\mathbf{Br}=80$. Comb. vol. of vapour 1.

Bromum, *B.P. Brominium.* F. *Brome.* G. *Brom.*

Bromine, from *βϱώμος*. a stench, was discovered in 1826 by Balard, in *bittern*, the uncrystallisable residue of sea-water. A gallon of sea-water contains from ¾ to 1 grain of bromine combined with sodium or magnesium. It exists also in rock-salt, in brine-springs, as those of Cheshire, in some mineral waters (see p. 44), sea-weeds, marine animals, and in the ashes of sponge.

Preparation.—Bromine may be detached from its combination by passing chlorine through a solution containing a bromide, $MgBr_2+Cl_2=MgCl_2+Br_2$, or by the action of sulphuric acid and binoxyde of manganese on *bittern*, as in the liberation of iodine (see p. 75). The Bromine is separated by distillation in the same manner.

Character and Tests.—A dark brownish red, very volatile liquid, with strong suffocating odour somewhat resembling chlorine, sp. gr. 2·966. At the common temperature of the air it gives off red vapours like nitric peroxyde, and at a temperature of 145·4 it boils. At 9°·5 it forms a brittle crystalline solid of a reddish colour and metallic lustre; and if water be present, it crystallises in octohedra ($Br5H_2O$). It stains the skin yellow. Agitated with solution of soda in such proportion that the fluid remains very slightly alkaline, it forms a colourless liquid, which, if coloured by the further addition of a small quantity of the bromine, does not become blue on the subsequent addition of a cold solution of starch (absence of iodine). It destroys vegetable colours. Like iodine and chlorine, it combines directly with many metals. It is slightly soluble in water, more so in alcohol, and very soluble in æther. The aqueous solution soon becomes colourless acid, hydrobromic and oxygen being formed.

BROMIDES.—A bromide in solution is known by the bright yellow colour (free Br) produced on the addition of a few drops of chlorine water. And in a solid state by the production of red vapour on heating with binoxyde of manganese and sulphuric acid; or with nitric acid alone. Bromide of silver requires a large excess of ammonia for its solution. The bromides of lead and mercury are white; that of silver has a yellow tinge.

Action. Uses.—A local irritant and caustic; increases the activity of the lymphatic system. It is used in combination with potassium, sodium, or ammonium.

Pharmaceutical Uses.—In the preparation of the bromides of ammonium and potassium, and of solution of bromine, in which it is employed as a test.

Dose.—½ to 1 fluid ounce of the aqueous solution.

Antidotes.—The same as for iodine (see p. 78).

1. **Solution of Bromine,** *P.B.* Prepared by shaking together 10 minims of bromine and 5 fluid ounces of water in a well stoppered bottle, and keeping the solution excluded from light. It is employed as a test.

AMMONII BROMIDUM, *P.B.*: $NH_4Br=98$ or $\mathbf{NH_4Br}=98$.

Preparation.—Bromide of ammonium may be prepared thus:—To 1 part of *iron filings*, suspended in 5 parts of *water*, add gradually about 3 parts of *bromine.* Agitate and heat gently until the whole is dissolved, forming a greenish liquid. To this add 1½ part of *bromine.* To the solution thus obtained add *solution of ammonia*, until a precipitate ceases to be formed. Filter; evaporate the clear liquid to form crystals.

The bromine and the iron, in equivalent proportions (160 and 56), unite to form a protobromide of iron ($FeBr_2$). Adding again half as much bromine, the perbromide (Fe_2Br_6) is formed. On the addition of solution of ammonia this is decomposed $Fe_2Br_6+3(H_4N)_2O=6H_4NBr+Fe_2O_3$, the ammonium uniting with the Br, and the liberated oxygen and iron falling together in combination as peroxyde of iron.

Characters and Tests.—Colourless crystals, which become slightly yellow by exposure to the air, and have a pungent saline taste. May be sublimed unchanged by the application of heat. Readily soluble in water; less soluble in spirit. A solution of the salt in water, mixed with mucilage of starch and a drop of an aqueous solution of bromine or chlorine, does not exhibit any blue colour (absence of iodine).

Action. Uses.—The effects of bromide of ammonium closely agree with those of bromide of potassium (which see). It is a *glandular stimulant* and a *nervine sedative* and *antispasmodic.* It is of great service in chronic bronchitis, where the attacks are of a spasmodic character, as it relieves the spasm, diminishes the viscidity of the sputum, and promotes expectoration.

Dose.—5 to 20 grains.

POTASSII BROMIDUM, *P.B.*: $KBr=119$ or $\mathbf{KBr}=119$.

Hydrobromate of Potash. F. *Bromure de Potassium.* G. *Brom Kalium.*

Bromide of potassium contains, in 100 parts, 67·17 of bromine and 32·83 of potassium.

Preparation.—Add 4 fluid ounces of *bromide* to 2 pints of *solution of potash*, contained in a glass or porcelain vessel, with constant stirring, until the mixture acquires a permanent brown tint (indicating a slight excess of bromide), evaporate to dryness, reduce the residue to fine powder, and mix it intimately with 2 ounces of finely powdered *wood charcoal*, and proceed exactly as in the preparation of iodide of potassium; the rationale of the process is the same. The decompositions will be understood by changing the "I" in the equations at page 80 for Br. The explanation of the process there given applies equally to the preparation of the bromide.

Characters and Tests.—In colourless cubical crystals, permanent in the air, neutral to test paper, without odour, but having a pungent saline taste, readily soluble in water, less so in spirit. The salt fuses without decomposition, and loses nothing of its weight (absence of water). When chlorine and then chloroform are added to its aqueous solution, the latter, after agitation, exhibits a red colour (due to bromine, liberated by the chlorine). The addition of tartaric acid causes a colourless crystalline precipitate (acid tartrate of potash, indicating the presence of potassium). 10 grains require for complete decomposition 840 gr. measures of the volumetric solution of nitrate of silver. (If more than 840 gr. measures be required, the presence of a chloride is indicated, the equivalent of Cl being less than half that of Br. If less, admixture with an iodide is indicated, because the equivalent of I is nearly double that of Br. The absence of iodide is more directly shown by the following test):—A solution of the salt mixed with mucilage of starch and a drop of an aqueous solution of bromine or chlorine (each of which liberates iodine from an iodide), does not exhibit any blue colour. The absence of sulphates and carbonates are indicated by freedom from turbidity on the addition of chloride of barium. Admixture with a chloride may be thus detected:—Mix the bromide with an excess of bichromate of potash and sulphuric acid, and distil into a solution of caustic ammonia. If a chloride be present, chlorochromic acid (CrO_2Cl_2) distils over, and turns the ammonical solution yellow, from the presence of chromate of ammonia. Bromine also comes over, but this forms with ammonia a colourless hydrobromate (Rose.)

Incompatibilities. — Chlorine, Acids, Acidulous Salts, Metallic Salts.

Action.—The operation of this salt is gentle and obscure, and it is eliminated unchanged by the kidneys. Large doses may be given for a considerable time without inducing any appreciable effects; ultimately symptoms of constitutional saturation or bromism appear. The patient may or may not complain of languor; but in a large proportion of cases a scattered, papular rash, closely resembling acne rosacea, appears on the face, neck, and shoulders. In other cases two or three boils arise on the neck or shoulders, or in the axilla, and, more rarely, a few small vesicles containing opalescent serum form on the arms or legs. In extreme cases, it is stated that excessive prostration of the mental and motor functions has followed the use of bromide of potassium. Although I have prescribed the drug extensively, and in many cases in doses of 80 grains and more, daily for long periods, I have never witnessed this result. The general effect is that of a sedative to the nervous system.

Medicinal Uses.—During the last ten years bromide of potassium has been largely used in all kinds of nervous disorders attended with excitement, and its powers have been greatly overrated; but yet those whose experience of its use is the greatest will, I believe, be the first to acknowledge that it exercises a beneficial influence in the following disorders: irritability of the sexual organs, and the discharges resulting therefrom; menorrhagia; epilepsy arising from disorders of the sexual function; and chorea. It has been recommended in spasmodic asthma, laryngismus stridulus, and in tetanus; but its influence is not at all marked in these diseases. In cerebral irritation due to exhaustion, it is a valuable remedy, and by checking the undue irritation acts indirectly as a hypnotic. It does not, however, possess any direct soporific action. It has been said to produce complete anæsthesia of the velum palati and pharynx for a while; but I have never been fortunate enough to secure this effect when I have used it for laryngoscopic examinations, nor can I believe that it is ever induced, since no patient of mine under the influence of the drug has ever complained of any difficulty of deglutition. Bromide of potassium has the further reputation of arresting the growth and of reducing fibrous tumours of the uterus, and of removing bronchocele, scrofulous tumours, and enlargement of the spleen; but its efficacy in these cases, if not altogether doubtful, cannot be compared with that of iodide of potassium.

Dose.—5 to 30 grains three times a-day.

CHLORINE: Cl=35·5 or **Cl**=35·5. Comb. vol. 1.

Chlorum, *B.P.* *Chlorinium.* F. *Chlore.* G. *Chlor.*

Chlorine, named from its characteristic yellowish green colour (χλωϱὸς), was discovered by Scheele in 1774. It was proved to be an elementary body by H. Davy in 1809. Chlorine is not found in a free state in nature, but combined with metals in great abundance, chiefly as chloride of sodium, in rock and sea salt. Chloride of sodium is an essential constituent of the juices both of animals and plants, and free hydrochloric acid is essential to the digestive process.

Preparation.—Chlorine, bromine, and iodine are separated from their combination with hydrogen by means of binoxyde of manganese. One half of the halogen being set free, and the other remaining in combination with the manganese, water being formed by the union of the hydrogen of the acid with the oxygen of the binoxyde, thus $MnO_2+4HCl=MnCl_2+2H_2O+2Cl$. Three ounces of the powdered binoxyde heated in a flask with 2 fluid ounces of commercial hydrochloric acid, diluted with 3 ounces of water, yield between 3 and 4 gallons of the gas. By means of the binoxyde and sulphuric acid the whole of the halogen may be liberated from the chlorides, bromides, or iodines; thus for chlorine 3 parts of finely powdered binoxyde, 4 parts of table salt, and 10½ parts of sulphuric acid diluted with 7 parts (all by weight) of water, are heated together in a glass retort, thus :—

$$2NaCl+MnO_2+3H_2SO_4=2NaHSO_4+MnSO_4+2H_2O+Cl_2.$$

Chlorine must be collected over warm water.

Properties.—Chlorine is a transparent greenish-yellow gas ; its sp. gr. is 2·47. 100 c. i. weigh about 77 grs. Under a pressure of about 4 atmospheres, it is reduced to a bright yellow liquid. It has an astringent taste, and a suffocating, pungent odour: even when diluted with air, it causes severe spasm of the glottis when inhaled. Cold water absorbs about twice its volume. It is a non-conductor of electricity. It is soluble in half its bulk of cold water, the solution having a yellow colour, and the taste and odour of chlorine. It forms a definite hydrate ($Cl,5H_2O$), which crystallises at 32°, and is decomposed with the evolution of Cl at a gentle heat.

The great feature of Cl is its great affinity for hydrogen; a taper burns in the gas with a dull red, sooty flame—the products of combustion being hydrochloric acid and soot. Phosphorus, finely divided antimony, copper, brass, and some other metals, combine directly with Cl, with the formation of heat and light. Organic substances rich in hydrogen are speedily decomposed by Cl. Turpentine and the like actually take fire spontaneously. Owing to this affinity for hydrogen, Cl possesses two characteristic properties, viz., bleaching and deodorant. The vegetable colouring matters usually contain hydrogen. Chlorine unites with it to form hydrochloric acid (HCl); and for every atom of hydrogen so removed, an atom of Cl is substituted; and these chlorinous compounds are more or less completely colourless. Animal emanations and the exhalations of decomposing organic matters are decomposed in a similar manner, thus Cl immediately destroys the odour of sulphide of hydrogen—$H_2S+Cl_2=2HCl+S$—the sulphur being precipitated.

Tests.—Chlorine is known by its colour, suffocating odour, and its bleaching properties. Nitrate of silver produces a white curdy precipitate (AgCl) in a solution containing chlorine (see "Chlorides" below).

Action. Uses.—Suffocating if inhaled. Rubefacient. Disinfectant.

Antidotes.—Inhalation of ammoniacal gas with care, and vapour of warm water. See also *Liquor Chlori.*

Pharmaceutical Uses.—Chlorine is used in the preparation of the following:—Liquor chlori, Calx chlorata, Liquor sodæ chloratæ.

CHLORIDES.—Chlorine combines with all the elements. The chlorides of the metals correspond to their oxydes; they are usually soluble, and are readily recognised by the evolution of chlorine when heated with MnO_2 and H_2SO_4 as above; and by the formation of a curdy white precipitate (AgCl) with a solution of nitrate of silver, soluble in ammonia and insoluble in nitric acid, becoming dark violet on exposure to light and fusing into "*horn silver.*"

1. Liquor Chlori, *B.P.* *Solution of Chlorine.* F. *Chlore liquid.* G. *Chlorwasser.*

Preparation.—Put 1 ounce of *black oxyde of manganese* into a gas bottle, and having poured upon it 6 fluid ounces of *hydrochloric acid* diluted with 2 ounces of *water*, apply a gentle heat, pass the gas evolved, through 2 ounces of the water in a wash-bottle, and thence to the bottom of a three-pint bottle containing 32 fluid ounces of water, the mouth of which is loosely plugged with tow. As soon as the chlorine ceases to be developed, disconnect the bottle, cork it loosely, and shake until the chlorine is absorbed; then transfer the solution to a well-stoppered green glass bottle, and keep it in a cool and dark place. The process yields a pure solution of chlorine. The chlorine is dissolved in half its volume of water, and constitutes ·006 of the solution by weight. It is liable to be decomposed by light, oxygen being evolved from the decomposition of the water, and HCl formed by the combination of the chlorine with the hydrogen.

Characters and Tests.—A yellowish-green liquid, smelling strongly of chlorine, immediately discharging the colour of a dilute solution of sulphate of indigo. Sp. gr. 1·003. Evaporated it leaves no residue. When 20 grains of iodide of potassium dissolved in an ounce of water are added to 439 grains (1 fluid ounce) of this preparation, the mixed solution acquires a deep red colour (free iodine), which is discharged by 750 gr. measures of the volumetric solution of hyposulphite soda, corresponding to 2·66 grs. of chlorine.

Dose.—10 to 20 minims.

Action and Uses.—Irritant; when diluted, stimulant, either internally or as a lotion or gargle. It is commonly used in putrid conditions of the throat and lungs, as a disinfectant and local stimulant. Cautiously used, it is an antidote in poisoning by hydrocyanic acid and sulphuretted hydrogen.

Pharmaceutical Uses.—It is employed in testing for iodine, bromine, and quinine.

Antidotes.—Lime Water, Magnesia, Chalk, Soap, White of Eggs, Dilution.

2. Vapor Chlori, *B.P.* *Inhalation of Chlorine.*

Preparation.—Put 2 ounces of *chlorinated lime* into a suitable apparatus, moisten it with *water*, and let the vapour which rises be inhaled.

Chlorine gas is evolved (see p. 88), which removes the odour of fœtid exhalations in putrid sore throat, diphtheria, gangrene of the lung, &c.

OXYDES OF CHLORINE.—Of the oxydes of chlorine, only two require notice in this work. They are hypochlorous acid (HClO) and chloric acid ($HClO_3$). The first will be considered under the article Calx chlorata, the second under Chlorate of potash.

HYDROCHLORIC ACID, $HCl = 36{\cdot}5$ or $HCl = 36{\cdot}5$. Comb. vol. 2. *Muriatic Acid Gas. Hydric Chloride.*

Under the influence of sunlight or flame, a mixture of 1 vol. each of chlorine and hydrogen combine with explosive violence to form two volumes of hydrochloric acid. It may be thus obtained, or by the process described below.

In its pure form it exists as a colourless acid gas with a pungent suffocating smell, and acid taste. It has been reduced to a colourless liquid by cold, and by a pressure equal to 40 atmospheres at 50°. Heat has no effect upon it. It extinguishes all burning bodies immersed in it. It has so great an affinity for water, that it attracts it from the atmosphere, producing white fumes. 100 c. i. weigh 39·64 grs; sp. gr. 1·24. Water at 40° dissolves nearly its own weight, or about 480 times its volume of this gas, increasing about one-third in bulk, and acquiring a sp. gr. of 1·2109, and thus forming the compound next following.

Solution of Hydrochloric Acid. *Muriatic Acid. Chlorhydric Acid. Spiritus Salis or Spirit of Salt. Marine Acid.* F. *Acide Hydrochlorique.* G. *Salzsäure, Chlorwasserstoffsäure.*

Geber and the Arabs were probably acquainted with this fluid, and the Hindoos knew it by a name equivalent to *spirit or sharp water of salt.*

When water is saturated with the gas as above described, it forms a colourless fuming liquid, containing about 43 per cent. of acid, and 3 equivs. of water to 1 of hydrochloric acid gas ($HCl,3H_2O$). Heated in a retort, this strong acid evolves HCl freely, until the fluid contains about 20 per cent. of it, and attains a sp. gr. of 1·100. It then distils unchanged. A weaker acid, on the other hand, loses water when distilled until it acquires a sp. gr. of 1·100, and the acid then distils unchanged. This acid contains 8 equiv. of water and 1 of hydrochloric acid ($HCl,8H_2O$). The commercial acid has a density of about 1·180. It is yellow, from the presence of a trace of iron (derived from the iron retorts in which it is prepared), and is usually contaminated with chlorides of sodium and arsenic (derived from the ingredients used in its preparation), and with sulphuric and sulphurous acids and free chlorine. An acid, free from iron, chlorides, and sulphuric acid, is easily obtained from this by diluting to the sp. gr. of 1·10, and then distilling.

E. Davy gives the following table of the percentage by weight of HCl in hydrochloric acid of different strengths at a temperature of 77° Fahr.:—

Sp. gravity.	HCl in 100 parts.	Sp. gravity.	HC in 100 parts.
1·21	42·42	1·10	20·20
1·20	40·40	1·09	18·18
1·19	38·38	1·08	16·16
1·18	36·36	1·07	14·14
1·17	34·34	1·06	12·12
1·16	32·32	1·05	10·10
1·15	30·30	1·04	8·08
1·14	28·28	1·03	6·06
1·13	26·26	1·02	4·04
1·12	24·24	1·01	2·02
1·11	22·22		

In contact with the more oxydisable metals (those which at a red heat decomposed water), liquid hydrochloric acid is decomposed, its H being liberated, and a chloride of the metal formed,—*e.g.*, $2HCl + Fe = FeCl_2 + 2H$. When hydrochloric acid and a metallic oxyde are brought together, the H of the one combines with the O of the other, forming water, and the other two elements unite to form a chloride, thus:—

In the case of a protoxide, $CaO + 2HCl = H_2O + CaCl_2$, and
In the case of a hydrated oxyde, $KHO + HCl = H_2O + KCl$, and
In the case of a sesquioxyde, $Fe_2O_3 + 6HCl = 3H_2O + Fe_2Cl_6$;
but when there is no corresponding chloride, then free Cl is evolved, thus:—$MnO_2 + 4HCl = MnCl_2 + 2H_2O + 2Cl$,—the usual process for the preparation of chlorine.

1. Acidum Hydrochloricum, *B.P. Hydrochloric Acid.*

Hydrochloric acid gas, HCl or **HCl**, dissolved in water, and forming 31·8 per cent. by weight of the solution.

Preparation.—Pour 44 fluid ounces of *sulphuric acid* slowly into 32 fluid ounces of *water;* and when the mixture has cooled, add it to 48 ounces of *chloride of sodium*, previously introduced into a flask having the capacity of at least one gallon. Connect the flask by corks and a bent glass tube with a three-necked wash-bottle, furnished with a safety tube, and containing four ounces of water; then, applying heat to the flask, conduct the disengaged gas through the wash-bottle into a second bottle containing 3 fluid ounces of distilled water, by means of a bent tube dipping about half-an-inch below the surface, and let the process be continued until the product measures 66 ounces, or the liquid has acquired a specific gravity of 1·16. The second bottle must be kept cool during the whole operation. In this process, half the hydrogen of the sulphuric acid combines with the Cl of the chloride; the remainder, and the sulphoin unite with the sodium to form hydro-sodic sulphate, thus:—$NaCl + H_2SO_4 = HCl + NaHSO_4$.

1 ounce of chloride of sodium yields 350 cub. in. of the gas.

Characters and Tests.—A nearly colourless and strongly acid liquid, emitting white vapours having a pungent odour; sp. gr. 1·16. When evaporated to dryness, it leaves no residue. It gives with nitrate of silver a curdy white precipitate (AgCl; see Chlorides, p. 88), soluble in excess of ammonia; insoluble in nitric acid. 114·8 grains, mixed with half an ounce of water, require for neutralisation 1000 grain measures of the volumetric solution of soda. When diluted with four times its volume of water, it gives no precipitate with solution of chloride of barium, or with sulphuretted hydrogen (absence of sulphates and metallic impurities, iron especially), does not tarnish nor alter the colour of bright copper foil when boiled with it (absence of the less oxydisable metals, but especially antimony and arsenic, which see). If a fluid drachm of it, mixed with half an ounce of water, be put into a small flask with a few pieces of granulated zinc, and while the effervescence continues, a slip of bibulous paper wetted with solution of subacetate of lead be suspended in the upper part of the flask above the liquid for about five minutes, the paper will not become discoloured (indicating the absence of sulphurous acid, which if present is deoxydised, the sulphur uniting with the hydrogen as it separates from the chlorine, thus—$3Zn + 6HCl + SO_2 = 2H_2O + 3ZnCl_2 + H_2S$).

Even when heated with the acid, gold leaf is not dissolved, showing the absence of nitric acid and of free chlorine and bromine. The absence of chlorine is further shown by an inability to discharge the colour from a solution containing a trace of sulphate of indigo.

Action and Uses.—The strong acid is a corrosive poison, but may be applied externally as an escharotic. When diluted it is used topically as a gargle to relaxed or putrid sore throat. Internally, it may be given (dilute) to act generally as an acid, it also possesses an astringent action. As this acid is a natural and essential constituent of the normal gastric juice, it is often used in morbid conditions of that secretion, especially when there is deficiency of acid. Hydrochloric acid may be used in phosphaturia; it has been employed by some in putrid fevers. As with the other mineral acids, the dilute acid only is employed as a tonic.

Antidotes.—Magnesia; solution of Soap, as easily procurable; the Bicarbonates of soda and potash; Milk; Demulcents. Chalk is to be avoided on account of the deleterious effects of chloride of calcium.

2. **Acidum Hydrochloricum dilutum**, *P.B.* *Dilute Hydrochloric Acid.*

Preparation.—Dilute 8 fluid ounces of *hydrochloric acid* with 16 ounces of *water;* then add more water, so that at a temperature of 60° it shall measure 26½ fluid ounces. Or as follows:—*Water*, a sufficiency. Weigh 3060 grains of *hydrochloric acid* in a glass flask, the capacity of which, to a mark on the neck, is 1 pint; then add distilled water until the mixture, at 60° temperature, after it has been shaken, measures a pint.

Tests.—Sp. gr. 1·052. 345 grains (6 fluid drachms) require for neutralisation 1000 grain measures of the volumetric solution of soda, corresponding to 10·58 per cent. of real acid. As with the other dilute acids, 6 fluid drachms contain 1 equiv. or 36·5 grains of HCl or HCl.

Dose.—10 to 20 minims in some bland or sweetened fluid or bitter infusion. A fluid drachm mixed with an ounce of honey may be applied with a brush to an ulcerated sore throat.

Incompatibilities.—Alkalies; most Oxides and Carbonates; Sulphides; Tartrate of potash; Potassio-Tartrate of antimony; Nitrate of silver; Acetate of lead.

NITRO-HYDROCHLORIC ACID.

Acidum Nitro-hydrochloricum. Aqua regia. F. *Eau régale.*
G. *Königswasser.*

The Arabs must have been acquainted with this acid, as they had a solvent for gold.

When one part of nitric acid and three parts of hydrochloric acid are mixed together and gently heated, red fumes, composed of a mixture of nitric oxydichloride and chlorine, are evolved:

$$2HNO_3 + 6HCl = 2NOCl_2 + 4H_2O + Cl_2.$$

At 90° the former condenses as a heavy red liquid, and the latter escapes free. Nitric oxydichloride ($NOCl_2$) is peroxyde of nitrogen, in which one atom of the oxygen is substituted for 2 atoms of chlorine; or it may with equal propriety be regarded as a compound of nitric oxyde and chlorine. Thus, when brought into contact with mercury, calomel and nitric oxyde are immediately formed, $NOCl_2 + 2Hg = 2HgCl + NO$. Water also decomposes it with equal facility, but the solution contains hydrochloric acid and peroxyde of nitrogen, $NOCl_2 + H_2O = NO_2 + 2HCl$. We may assume, therefore, that the dilute acid of the Pharmacopœia is a mixture of undecomposed nitric and hydrochloric acids, holding in solution free chlorine and peroxyde of nitrogen.

Properties.—Nitrohydrochloric acid is of a golden yellow colour, with the suffocating odour of chlorine, and the irritant corrosive properties of the strong acids.

Tests.—It is distinguished by the property of dissolving gold, which is owing to the presence of chlorine. Nitrate of silver produces a precipitate of chloride of silver, soluble in ammonia, but insoluble in nitric acid.

1. **Acidum Nitro-Hydrochloricum dilutum,** *P.B.* *Dilute Nitro-Hydrochloric Acid.*

Preparation.—Mix together 3 fluid ounces of *nitric acid* and 4 fluid ounces of *hydrochloric acid*, and let them remain for twenty-four hours in a quart bottle, the mouth of which is partially closed; then add 25 fluid ounces of *water* in successive portions, shaking after each addition, and preserve the mixture in a stoppered bottle.

The acids are mixed in their concentrated state, and kept undiluted for twenty-four hours, in order to bring about the decomposition above described.

Characters and Tests.—Colourless; sp. gr. 1·074. 352·4 grains (6 fluid drachms) require for neutralisation 920 gr. measures of the volumetric solution of soda.

Action. Uses.—A corrosive poison. When diluted, stimulant of the skin and of the liver. It is given internally in cases of lithic or oxalic deposit from the urine.

Dose.—5 to 20 minims, well diluted. Diluted with 15 to 20 parts of water, it may be used externally as a local bath. A piece of flannel, wrung almost dry out of the diluted acid, may be worn in contact with the skin for several hours continuously.

CARBON: C = 6 or C = 12.

Carbo. F. *Charbon.* G. *Kohlenstoff.*

Carbon is very extensively diffused in nature, as in coal, anthracite, graphite, and diamond. It forms a large portion of both vegetable and animal substances. Carbon is dimorphous, the *diamond* crystallising in cubes or regular octahedra, while *graphite* (plumbago or black-lead) occurs in hexagonal plates belonging to the rhombohedral system. Diamond is the purest form of native carbon, containing only traces of silica and ferric oxyde; it is remarkable for its great refracting power, and is a nonconductor of electricity. Graphite leaves from 2 to 5 per cent. of ash (silica and oxyde of iron). It is an excellent conductor of electricity. A pure amorphous form of carbon (*lamp-black*) is readily prepared by burning oils and resins with a deficient supply of oxygen. When heated in oxygen, both of these native forms of carbon are converted into carbonic anhydride. The artificial forms are readily dissipated when ignited in the air.

CARBO LIGNI, *B.P.* *Wood Charcoal.*

Wood charred by exposure to a red heat without access to air.

Preparation.—It is prepared by turfing over a conical pile of dry logs (fig. 26), a space being left in the centre and an aperture below, where the logs are fixed by brushwood; and when the whole heap is thoroughly ignited, the amount of air admitted is continually reduced by gradually closing up the lower orifice.

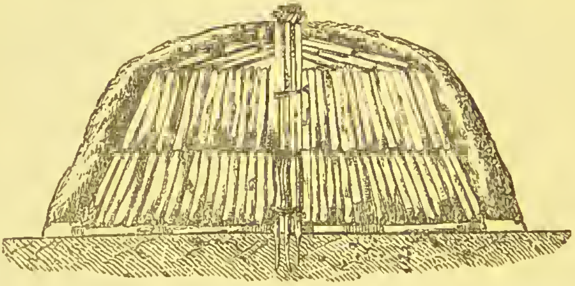

Fig. 26.

Characters.—In black, brittle, porous masses, retaining the shape and structures of the wood from which it was obtained; odourless and tasteless. Burnt in a free access of air, it leaves not more than 2 per cent. of ash. It possesses the remarkable power of condensing gases within its interstices. A cubic inch of wood charcoal will condense 90 cubic inches of ammonia, 55 of sulphuretted hydrogen, 35 of carbonic acid, 9 of oxygen, 7·5 of nitrogen, and 1·7 of hydrogen.

This power of condensing oxygen confers upon wood charcoal a remarkable oxydising power, by virtue of which it is a powerful disinfectant (Stenhouse). The offensive effluvia evolved from putrescent animal or vegetable matter, disappears when it is covered with a layer of charcoal; the putrefaction however continues, and the carbon is dissipated as carbonic anhydride, the hydrogen and nitrogen of the putrifying matter being oxydised into water and nitrate of ammonia. Charcoal possesses, probably by virtue of its oxydising power, the further property of removing colouring matters from organic substances; but this characteristic is much less conspicuous in vegetable than in animal charcoal, under which therefore it will be more properly discussed. After these qualities have been exhausted by use, they may be restored by drying and igniting the charcoal.

Action. Uses.—Antiseptic and disinfectant; corrects the fœtor of the breath and of the stools in dyspepsia and dysentery. Dr Stenhouse has recommended the use of a respirator packed with coarsely powdered wood charcoal to those who are exposed to noxious smells and pestilential effluvia, the oxydising action being sufficiently rapid to decompose these as they are drawn through the charcoal. As a disinfectant, layers of powdered charcoal may be exposed in the wards of hospitals, dissecting rooms, in the openings of sewers, &c. In a finely levigated state, wood charcoal is a valuable dressing to the peculiarly offensive suppurating surfaces resulting from severe burns, and to parts affected with moist gangrene. In these cases the surfaces should be thickly covered with the powder by means of a dredger.

Dose.—10 to 40 grains, in the form of biscuit.

1. **Cataplasm Carbonis**, *P.B.* *Charcoal Poultice.*

Preparation.—Macerate 2 ounces of *bread-crumb* in ½ pint of boiling water for 10 minutes, near the fire, then mix, and add 4 ounces of *linseed meal*, gradually stirring the ingredients, that a soft poultice may be formed. Mix with this ¼ ounce of *wood charcoal* in powder, and sprinkle ¼ ounce more on the surface of the poultice.

Use.—It is applied warm to foul ulcers to destroy the fœtor.

CARBO ANIMALIS, *P.B.* *Animal Charcoal. Bone* or *Ivory Black.*

The residue of bones which have been exposed to a red heat without the access of air. It contains 88 per cent. of tricalcic-phosphate and carbonate of lime; 2 per cent. of carbide with silicide of iron, and a trace of sulphide. It is bitterish, and may readily be distinguished from vegetable charcoal by burning a little of it on a red-hot iron, when a large residue is left. The ash, consisting chiefly of the phosphate of lime, is with difficulty acted on by sulphuric acid; that of wood charcoal, being composed of carbonates, dissolves readily. An almost pure animal charcoal may be prepared by drying and igniting blood. Bone black is employed in the preparation of the next variety of carbon.

1. **Carbo Animalis purificatus,** *B.P.* *Purified Animal Charcoal.*

Animal charcoal, from which the earthy salts have been almost wholly removed.

Preparation.—Digest 16 ounces of *bone black* for two days in 10 fluid ounces of *hydrochloric acid*, diluted with a pint of *water*, at a moderate heat, agitating from time to time; collect on a filter and wash with water till what passes through gives scarcely any precipitate with nitrate of silver. Dry the charcoal, and then heat it to redness in a closely covered crucible.

The HCl dissolves the phosphate and decomposes the carbonate of lime, as well as any sulphide, with the disengagement of carbonic acid, and a trace of sulphuretted hydrogen, chloride of calcium being left in solution.

Characters.—A black pulverulent substance; inodorous, and almost tasteless. Tincture of litmus, diluted with 20 times its bulk of water, agitated with it and thrown upon a filter, passes through colourless, proving its power of decolorising. Burned at a high temperature with a little red oxyde of mercury and free access of air, only a trace of inorganic matter remains (carbide of iron and silica.)

The oxyde of mercury evolves oxygen, which ensures the combustion of the carbon, the mercury itself being dissipated.

Action. Uses.—Animal is more active than vegetable charcoal, for which it may be substituted in any case, and in the same dose.

It is chiefly employed by the sugar refiner and pharmaceutist as a decoloriser. It unites tenaciously with vegetable colours, and is employed to remove these in the preparation of citric and tartaric acids, and of the vegetable alkalies and their salts, as quinia, morphia, veratria. It is either mixed or boiled with the liquid to be decolorised, or the latter is allowed to filter through a layer of charcoal. But it is open to the serious objection that it tends also to combine with the alkaloid itself, and may remove it from the solution as well as the colouring matter (see Aconitia). Thus animal charcoal has been shown to be a valuable remedy in many cases of poisoning, as, if given immediately, it absorbs and renders inoperative the most powerful alkaloids, and even hydrocyanic acid. About half an ounce is sufficient to neutralise each grain of morphia or strychnia.

Dose.—20 to 60 grains.

OXYDES OF CARBON.—The two oxydes of carbon are important both to the chemist and medical practitioner.

1. **Carbonic Oxyde,** $CO=14$ or $CO=28$. Comb. vol. 2.

Is a colourless gas, tasteless, but having a faint oppressive smell, and is extremely poisonous when respired. Sp. gr. ·972.

It is formed when carbon is burned with a limited supply of oxygen. Though it extinguishes burning bodies, it will itself burn with a pale blue flame, as may often be seen on the surface of a coal fire. It is also formed when charcoal is slowly burned, and is necessarily deleterious in close apartments. Professor Dumas states, that it is much more dangerous than carbonic acid, and that an admixture with the air of $\frac{1}{200}$th part will prove fatal. In accidental conflagrations it is often more destructive to life than the fire itself, as it ascends to the upper chambers, and suffocates the sleeping inhabitants. Bernard states that the whole of the blood of a person poisoned by CO has a bright arterial colour. If this be a correct observation, we have a means of discriminating between the fatal effects of carbonic acid and carbonic oxyde.

2. **Carbonic Acid or Carbonic Anhydride,** $CO_2=22$ or $CO_2=44$. Comb. vol. 2. *Acidum Carbonicum. Fixed Air. Spiritus lethalis. Choke Damp.* F. *Acide Carbonique.* G. *Kohlen säure.*

Carbonic acid has long been known from its effects; but its nature was not explained until 1757 by Dr Black. It is abundantly diffused in nature. The atmosphere contains 0·4 parts in 1000. It issues from the earth in many situations, as the Grotto del Cane in Italy, and the Valley of Poison in Java; but especially in Germany, near the Lake of Laach, where Bischoff calculates that not less than 600,000 lbs. escape daily, and in such quantities in the Brohltahl as to enable him to employ it in some chemical operations. It issues also, combined with water, from many mineral springs, giving to them their sparkling brilliancy (see p. 40). It is by an excess of carbonic acid that the carbonates of lime, magnesia, and iron are held in solution in different waters. It is formed in large quantities in the combustion of charcoal, &c., and during fermentation. It is constantly exhaled from the skin and lungs of animals, expired air containing from 3 to 5 per cent. of its volume. Plants exhale it freely at night or in the shade. Combined with bases, it exists in large quantities in the interior of the earth, and in the mountain masses of marble, limestone, chalk, &c.

Properties.—Carbonic anhydride, at ordinary temperatures, is a colourless gas, of which the solution in water has an acid taste and reaction. It is very heavy; sp. gr. 1·52; 100 c. i. weigh 47·25 grs. Water dissolves its own volume, but may be made by pressure to take up a much larger quantity, when it will redden vegetable blues, but not permanently, as the acid escapes when exposed to the air. When subjected to pressure of 40 atmospheres, it is reduced to a colourless liquid; and, by the effect of the great cold, −148°, produced by its evaporation, it may be converted into a solid. The gas extinguishes flame and all burning bodies, except potassium; it is also fatal to animal life.

Preparation.—It may be obtained from *chalk*, or better, coarsely powdered *marble*, by the addition of hydrochloric acid diluted with seven times its bulk of water, $CaCO_3 + 2HCl = CaCl_2 + H_2O + CO_2$. As the carbonates are decomposed by all strong acids, even acetic acid may be used for its liberation. Whenever the gas is required for therapeutical use, it must be passed through a little water in a wash-bottle.

Tests.—Carbonic acid may easily be detected by its evanescent action in reddening litmus paper, by rendering lime water turbid, by precipitating lime and baryta from their solutions, and by these precipitates being soluble in acetic acid with effervescence.

Action. Uses.—Acts as a stimulant and sedative when taken into the stomach, but is fatal to animal life when breathed. It may be prescribed in the forms of Liquor potassæ effervescens, Liquor sodæ effervescens, as effervescing draughts, or as ordinary bottled soda water, which contains no alkali or only a trace; or we may prescribe mineral waters, such as Seltzer and Apollinaris. Death not unfrequently occurs from breathing this gas in descending into cellars, wells, mines, &c.; also from sleeping near brewers' vats, lime-kilns, in green-houses; or in small apartments, or cabins on board ship with a charcoal fire. When the air contains as much as 3 or 4 per cent. of its volume, it is unable to support either combustion or respiration, and then acts as a narcotic poison, producing asphyxia, and rendering the whole of the blood very dark. Externally carbonic acid gas seems to act as an anæsthetic, and baths of the gas have been used by continental physicians in dysmenorrhœa, cancer, and other painful disorders. But as medicine is preventative as well as curative, we have much more to do with its deleterious than with its curative action. The drowsy languor, often amounting to a feeling of syncope, which is commonly experienced in ill-ventilated rooms and crowded assemblies, as in churches and theatres, is due to the early stage of poisoning by carbonic acid; and this condition, moreover, is one which predisposes, on reaction, to internal congestions. In the treatment of delicate persons and those who have actual pulmonary disease, these facts must be borne in mind, or our curative efforts may be defeated by an occasional exposure to an atmosphere laden with this poisonous gas.

Pharmaceutical Uses.—In the preparation of the bicarbonates of potash, soda, and magnesia; and of potash and soda waters.

CARBONATES.—According to the binary theory, these salts must be regarded as bibasic. All, excepting those of the metals of the alkalies, are insoluble; but many, especially those of the metals of the earths, are soluble in water charged with carbonic acid, and are deposited from the solution, as the CO_2 escapes, in a crystalline form (see solution of carbonate of magnesia). All dissolve with effervescence in dilute nitric or acetic acid. All, excepting those of the metals of the alkalies and carbonate of baryta, are decomposed by prolonged ignition, CO_2 escaping, and the metallic oxyde being left. The soluble carbonates (like free carbonic acid) give a milky turbidity with salts of lime and baryta, the white precipitate dissolving with effervescence of CO_2 in any dilute acid.

HYDROGEN and CARBON.

Compounds of hydrogen and carbon are usually denominated hydrocarbons. Of these a few are officinal, and we require to be acquainted with the properties of others, as they are deleterious. Thus, of those which are gaseous, the two following form the principal ingredients of coal-gas. Bisulphide of carbon, ammonia, and benzol are also present in common coal-gas, and give it its characteristic odour.

Light Carburetted Hydrogen or Marsh Gas ($CH_4 = 16$). This gas may be regarded as a bihydruret of carbon. As a result of the decomposition of vegetable matters, it may be seen escaping in bubbles from the surface of stagnant pools, and also in stirring up fœtid mud. It issues sometimes in immense quantities from fissures in coal-mines, and, mixing with the oxygen of the air, forms the fatally explosive *inflammable air* or *fire-damp* of miners. The gas in exploding wholly deprives ten times its bulk of air of oxygen, forming 2 volumes of steam and 9 volumes of "*after damp*," composed of a mixture of 1 vol. of carbonic anhydride and 8 vols. of nitrogen.

Olefiant Gas ($C_2H_4 = 28$), named from forming an oily liquid by combining with chlorine, is a gas composed of 2 vols. of carbon vapour and 2 of hydrogen condensed into 1 vol. Like the former, this gas is found in coal-mines.

Paraffin oil, obtained by the distillation of coal, is stated by Professor Hofmann to be a "liquid olefiant gas." It is largely used in illumination.

Other hydrocarbons are either solid or liquid. Petroleum or rock oil was till lately officinal; and naphtha, whether obtained artificially or as a product of nature, is sometimes used medicinally. As these natural products result from vegetable decomposition in remote ages, and as the artificial products may be obtained by present decomposition of vegetable matter, it will be convenient to treat of all of these nearly allied substances together. So also of oil of turpentine, tar, kreasote, and the products of the distillation of coal. (See Coniferæ.)

CARBON and NITROGEN.

These two elements combine together to form the very remarkable body called cyanogen (*κύανος, blue, γεννάω, to produce*), the compounds with iron forming Prussian blues. (See Ferrocyanide of Iron, p. 100.)

Cyanogen, $C_2N = 26$, **CN** or **Cy** $= 26$. Comb. vol. 2. F. *Cyanogène.*

Cyanogen may be regarded as a combination of 2 vols. of carbon vapour and 1 vol. of nitrogen condensed into 1 vol. But the two elements are of themselves incapable of combining directly, requiring as they do the intervention of a third body—potassium or sodium. It is a poisonous, colourless gas, of a pungent odour, burning with a purplish flame, soluble in ¼ its bulk of water, and condensible into a colourless liquid. It is interesting, as a compound body, in acting like the simple elements in combining with metals, and forms with hydrogen an acid, the hydrocyanic, which is of fearful importance on account of its rapidly deleterious effects. Cyanogen is the type of the compound *radicals* of organic chemistry.

POTASSÆ PRUSSIAS FLAVA, *P.B.* *Yellow Prussiate of Potash. Ferrocyanide of Potassium* or *Potassic Ferrocyanide.*

$$K_2FeC_6N_3+3HO=184+27 \text{ or } K_4FeCy_6,3H_2O \text{ or } K_4Fcy,3H_2O$$
$$=368+54.$$

This salt, which is a double cyanide of potassium and iron, is the source of cyanogen and its compounds. It is prepared by fusing together, in a covered iron pot, about 5 parts of refuse animal matter, such as dried blood, horns, clippings of hides, &c., and 2 parts of carbonate of potash, with an excess of iron filings. When cold, the mass is broken up and digested with water, which dissolves out the potassic ferrocyanide, and on evaporation deposits it in fine four-sided tablets with shelving edges. Potassium and sodium have the remarkable power of determining the union of the C and N of organic matters at a high temperature, and the cyanogen thus formed combines directly with the potassium to form a cyanide; if iron be presented at the same time, a double cyanide of the metals is formed, as represented in the above formula. The cyanides of iron in combination with other cyanides give rise to two classes of compounds, represented by the yellow and red prussiate of potash respectively. Each is supposed to contain a separate radicle, *ferrocyanogen* $FeCy_6$ or Fcy, being the radicle of the yellow prussiate, and *ferricyanogen* $FeCy_6=Fdcy$, that of the red prussiate of potash; the first is tetrabasic, the second tribasic.

Characters and Tests.—Larger yellow crystals, permanent in the air, of a tough fibrous structure, soluble in water, insoluble in alcohol. The aqueous solution precipitates deep blue with persulphate of iron, a rich brown with sulphate of copper—it is erroneously termed "brick-red" in the Pharmacopœia; and white with acetate of lead. Heated with diluted sulphuric acid, vapours of hydrocyanic acid gas are evolved.

1. **Solution of Yellow Prussiate of Potash,** *P.B.* = 1 part of the salt in 20 of water, is employed as a test, giving with the protosalts of iron a greyish precipitate, which, by absorption of oxygen from the air, soon becomes blue (basic Prussian blue Fe_4Fcy_2,Fe_2O_3,H_2O); with the protosalts of iron, a deep blue (Prussian blue, $Fe_4Fcy_3H_2O$); with the salts of copper, a rich brown (ferrocyanide of copper, Cu_2FcyH_2O); with those of lead, a white precipitate (ferrocyanide of lead, Pb_2FcyH_2O).

POTASSÆ PRUSSIAS RUBRA. *Red Prussiate of Potash.*

$K_3,Fe_2C_{12}N_6=329$ or K_3FeCy_6 or $K_3Fdcy=329$.

Ferricyanide of potassium is prepared by passing a stream of chlorine through a solution of ferrocyanide until it ceases to give a blue precipitate with a persalt of iron. The chlorine removes 2 equivs. of potassium as chloride:—$2K_4FeC_6N_6+Cl_2=2KCl+2K_3FeC_6N_6$. The solution yields on evaporation bold, ruby red, anhydrous right rhombic prisms, soluble in 2½ parts of water at 60° and 1⅓ part at 212°, insoluble in alcohol. An aqueous solution gives no precipitate, but only an olive-green colouration with persalts of iron; a brilliant Prussian blue (Turnbull's blue, Fe_3Fdcy_2,H_2O) with the protosalts of iron.

1. **Solution of Red Prussiate of Potash**, *P.B.* = 1 part of the salt in 20 parts of water. It is used to indicate the proper state of oxydation of the proto- and persalts of iron respectively. Thus absence of precipitate when mixed with solutions of the peroxyde, persulphate, citrate of iron and quinine, or tartarated iron, proves that the peroxydation of the iron is complete. On the other hand, the production of a blue precipitate in solutions of sulphate, iodide, and saccharated carbonate, proves that the iron is in the condition of protoxide.

HYDROCYANIC ACID: $HC_2N=27$ or $HCy=27$. Comb. vol. 2.

Hydric Cyanide. Prussic Acid. F. *Acide hydrocyanique.* G. *Blausäure.*

It was called Prussic acid, because it was first obtained from Prussian blue (p. 100). Scheele discovered the diluted acid in 1782, and Gay-Lussac the anhydrous in 1815. It was used medicinally by Brera in 1809; by Majendie in 1817; and in 1819 by Dr A. T. Thomson in this country. But its effects had been obtained long before by the use of laurel water. It exists in the leaves and seeds of the Pomeæ and Amygdalæ divisions of the Rosaceæ, and its existence in these, and especially in apple pips, must be borne in mind when we look for prussic acid in the human body.

This acid is composed of 1 vol. of Cy and 1 vol. of H united without condensation. It is easily prepared by the action of a strong mineral acid on any cyanide; thus it is evolved when mercuric cyanide is heated with hydrochloric acid:—$HgCy_2+2HCl=HgCl_2+2HCy$. The action of sulphuric acid on the cyanides is strictly analogous to its action on the chlorides; thus, $2KCy+2H_2SO_4=2KHSO_4+2HCy$.

To a solution of cyanide of potassium, sulphuric acid diluted with its own bulk of water is added, in the proportion of 1 part of acid to 2 parts of the salt. At first enough heat is developed to drive off the acid; subsequently the heat of a lamp will be required to effect the distillation. The products of distillation are conducted through a long U-shaped tube, the first part of which is filled with fragments of potassic cyanide to arrest any sulphuric acid that may pass over, and the second with calcic chloride to retain aqueous vapour; the acid is then conveyed into a bottle cooled with a mixture of ice and salt. In this vessel the anhydrous acid condenses. The operation should be conducted in the outer air, or under a chimney with a very strong upward draught, so as to convey all trace of the vapour of the acid from the operator, otherwise his life would be greatly endangered.

Anhydrous hydrocyanic acid resembles in its chemical relation the hydrogen acids of the halogens. It is a clear colourless liquid, sp. gr. 0·7, so exceedingly volatile that if it be dropped on a glass plate, the chief portion is frozen by the cold produced by its evaporation. The vapour has the odour of peach blossoms, and produces at first a feeling of suffocation, and then asphyxia. It burns with a flame like cyanogen, but paler; its acid properties are but feebly marked. Potassium burns in the vapour, potassic cyanide being formed; the liquid acid dissolves red oxyde of mercury, and forms a solution of $HgCy_2$, which may be crystallised out; with nitrate of silver it gives a flocculent precipitate of $AgCy$. Exposed to the day-light, the acid is decomposed, and becomes brown from the formation of paracyanogen (C_3N_3).

1. **Acidum Hydrocyanicum dilutum**, *P.B.* *Diluted Hydrocyanic Acid.*

This is composed of 2 parts by weight of the anhydrous acid, HC_2N or HCy, dissolved in sufficient water to make up 100 parts by weight.

Preparation.—Dissolve 2¼ ounces of *yellow prussiate of potash* in 10 fluid ounces of *water.* Dilute 1 fluid ounce of *sulphuric acid* with 4 fluid ounces of water, and when the mixture is cold, add it to the solution of prussiate of potash in a flask, arranged with a suitable condenser and receiver for distillation. Put 8 fluid ounces of *water* into the receiver; apply heat to the flask until, by slow distillation, the liquid in the receiver is increased to 17 fluid ounces. Add to this 3 fluid ounces of water, or as much as may be needed to bring the acid to the required strength,—viz., that 100 grains (or 110 minims) of it precipitated with a solution of nitrate of silver shall yield 10 grains of dry cyanide of silver.

In this process, 1 equivalent of the yellow prussiate is decomposed by excess of sulphuric acid into 3 equivs. of hydropotassic sulphate; 1 equiv. of an insoluble double cyanide of iron and potassium, in which the proportions of potassium and iron are equal; and 3 equivs. of hydrocyanic acid, thus—

$$K_4FeCy_6 + 3H_2SO_4 = 3(KHSO_4) + KFeCy_3 + 3HCy\,.$$

The following is a simple and reliable process for the preparation of a 2 per cent. acid. It was originally recommended by Everitt, and adopted by the L.P. Suspend 48½ grains of *cyanide of silver* in a fluid ounce of water containing 39½ grains of *hydrochloric acid;* agitate in a well-stoppered vial, allow the chloride of silver to deposit, and then decant the clear fluid, —$AgCy + HCl = AgCl + HCy$.

Characters and Tests.—A colourless liquid, with a peculiar odour; sp. gr. 0·997. It only slightly and transiently reddens litmus paper. A fluid drachm evaporated in a platinum dish leaves no fixed residue. Treated with a minute quantity of a mixed solution of sulphate and persulphate of iron, afterwards with potash, and finally acidulated with hydrochloric acid, it forms Prussian blue: the potash precipitates hydrated ferric and ferrous oxydes, which, on the addition of excess of HCl in the presence of the cyanide of potassium formed, leaves Prussian blue, thus—

$$18KCy + 2Fe_2O_3,3FeO + 18HCl = 18KCl + 9H_2O + Fe_4Fcy_3.$$

It gives no precipitate with chloride of barium (absence of sulphuric acid); but with nitrate of silver it gives a white precipitate (cyanide of silver), entirely soluble in boiling concentrated nitric acid (which distinguishes it from chloride of silver, and indicates freedom from chlorine, hydrochloric acid, or chlorides). 270 grains of the dilute acid, rendered alkaline by the addition of solution of soda, require 1000 grain measures of the volumetric solution of nitrate of silver to be added before a permanent precipitate begins to form, which corresponds to 2 per cent. of the real acid. The presence of chlorides does not interfere with this test. (The following is the reaction:—$AgNO_3 + 2NaCy = NaNO_3 + NaCy,AgCy$,—a soluble double cyanide of sodium and silver being formed. When an excess of argentic nitrate is used, the silver begins to take the place of the sodium; and for every equivalent decomposed 2 equivs. of AgCy falls, forming a copious and permanent precipitate:—$NaAgCy_2 + AgNO_3 = NaNO_3 + 2AgCy$.) The diluted acid of the shops has been found to vary in strength from 1·4 to 5·8 per cent. of anhydrous acid; hence the need of this test.

The dilute acid may be preserved unchanged for years if it be completely excluded from light, and kept in properly stoppered bottles. The presence of a little sulphuric acid renders it more stable; but if the bottle containing it be imperfectly stoppered, the volatile acid rapidly escapes, and in the course of a few weeks only water remains. The frequent opening of the bottle in dispensing gradually weakens the acid.

Action and Uses.—In doses of from 30 to 60 minims, the 2 per cent. acid is fatal to life, causing death by paralysis of the respiration, the inspirations falling rapidly to $\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{10}$, and then ceasing. When death occurs within two minutes, the heart contains only dark blood, the right cavities are gorged, and the action is nearly paralysed by pressure, but may be revived, four minutes after the respiration has ceased, by direct venesection. In one case I found the hearts of fœtal kittens pulsating fourteen minutes after the death of the mother. This condition of asphyxia usually comes on about a minute after the ingestion of the poison. The primary action is undoubtedly on the cerebro-spinal nerves; for the acid exerts a paralysing action on all nerves directly exposed to it. This is the key to its medicinal action; and when taken internally it exercises, independently of any local action on the alimentary canal, a general sedative action. It allays undue irritability of the peripheral nerves, both of the skin and mucous membrane. Thus, it is most beneficial in *gastrodynia* and *cramp of the stomach*, in reflex vomiting from irritation of the lungs in phthisis, and of the uterus in pregnancy and morbid conditions; in *cough*, depending on laryngeal or pulmonary irritation; and in *painful affections of the skin*, such as sometimes occurs when the skin is excoriated by the acrid discharges of epithelial cancer, or the nerves are tormented by the action of capsicum. It often gives relief from the distressing irritation of the severer forms of *urticaria*. It is also serviceable in *otalgia*, but must be used with excessive care, not more than two drops of the acid being used at a time.

Dose.—1 to 8 minims, from 3 to 5 being the usual dose for an adult. It may be given alone, with acids, or with the soluble alkalies, the cyanides of sodium, potassium, or ammonium being as efficacious as the acid itself. For the relief of cough, it may be administered in the form of vapour (see below). As a lotion, it may be used in the proportion of 1 part to 20 or 40 of water.

Antidotes.—Before the supervention of asphyxia, 2 drachms of sulphate of iron and a fluid drachm of the tincture of perchloride in 6 or 8 ounces of water, to be drank at once. During the state of asphyxia, bleeding from a jugular vein, artificial respiration, the cold douche, the inhalation of chlorine (a saucer containing a little chloride of lime, sprinkled with vinegar, being held near the mouth of the patient).

1. **Vapour Acidi Hydrocyanici.** *Inhalation of Hydrocyanic Acid.*

Mix 10 to 15 minims of diluted *hydrocyanic acid* with 1 fluid drachm of *cold water* in a suitable apparatus, and let the vapour that arises be inhaled.

Used in laryngeal or tracheal irritation, to allay cough or spasm.

CYANIDES.—The cyanides of the alkali metals are very soluble, and form with the insoluble cyanides of the metals soluble double cyanides (see **KCy,AgCy**, under tests, p. 103). They are decomposed by strong mineral acids with the liberation of **HCy**. The cyanides of mercury and silver, when heated to redness, yield cyanogen. The presence of a cyanide or of hydrocyanic acid in solution is ascertained by the following tests:—1. The formation of Prussian blue as given above. Or the test may be thus varied: heat the liquid with a little sulphuric acid; suspend in the neck of the flask a piece of paper moistened with solution of potash for a few minutes, and then drop upon it a weak solution of the mixed sulphates of iron; and lastly, immerse it in dilute sulphuric acid. If a trace of hydrocyanic acid or of a cyanide be present in the suspected fluid, Prussian blue is formed on the paper. 2. With argentic nitrate, a curdy white precipitate, which does not blacken on exposure to the air, and which, when dried and heated to redness, gives off inflammable cyanogen. 3. Acidulate with a few drops of HCl, and place a little of the fluid in a watch-glass; invert over it a second watch-glass containing a spread drop or two of hydrosulphate of ammonia. That which has been prepared some time, and is yellow from the presence of ammonic disulphide $(H_4N)_2S_2$, for a few minutes; then remove the latter, and dry it on a water-bath, thus:—$(H_4N)_2S_2+HCy$ liberated by the acid, gives $H_4NCyS+H_4NHS$. The sulphocyanide of ammonium remains; and when this is mixed with a drop or two of weak solution of ferric chloride, the blood-red colour of ferric sulphocyanide is developed.

1. **Cyanide of Potassium**, $KCy=65$.—The impure cyanide of commerce is prepared by fusing together 8 parts of ferrocyanide of potassium, deprived of its water of crystallisation, and 3 parts of carbonate of potash in an iron crucible, till CO_2 has ceased to be evolved, and the separated iron has subsided. The fused product is poured upon a stone slab, and immediately broken up and preserved in well-stoppered bottles. It is in the form of broken masses, white and opaque, smelling strongly of prussic acid, and extremely deliquescent. It consists of 5 equivs. of cyanide and 1 equiv. of cyanate; but it often contains large quantities of carbonate of potash. In the form of "cyanogen soap" it is used by the photographer for removing stains of argentic nitrate. When employed for the removal of marking ink, the fabric should be first wetted with iodide of potassium, and then with a strong solution of the cyanide. It is a very poisonous salt. Its aqueous solution decomposes spontaneously with the formation of formiate of potash and ammonia: $KCy+2H_2O=KCHO_2+H_3N$.

2. **Cyanide of Mercury**, which see.

AMMONIA: $H_3N=17$ or $H_3N=17$. Comb. vol. 2.

Volatile Alkali. Spirit of Hartshorn. F. *Ammoniaque.* G. *Ammoniak.*

Ammonia was probably known to Pliny, as he mentions the strong odour evolved from the mixture of lime and *nitrum*.* The Hindoos also were acquainted with the carbonate, and obtained it by mixing sal ammoniac 1 part and chalk 2 parts. Raymond Lully was acquainted with an impure solution of carbonate ammonia, obtained from putrid urine; and Basil Valentine mentions the "*spiritus salis urinæ.*" The name is derived from sal ammoniac. The aqueous solution was known to the earlier chemists, and called by them Volatile Alkali. It was first obtained as a gas by Priestley. (Experiments on Different Kinds of Air, 1774.) In 1756, Dr Black distinguished it from its carbonate. Berthollet and Gay-Lussac were the first to communicate precise ideas respecting its composition. A trace of ammonia exists at all times in the air. About 1 vol. in 20,000,000 vols. of air (Ville), being most abundant in a period of drought, and least so after prolonged rain.

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* Probably sal ammoniac, as several substances were included under *Nitrum*.

Rain-water contains from 1 to 3·5 parts in 1,000,000 parts; that of large towns furnishing the largest quantity. Owing to its solubility in water, the first showers contain the greatest quantity. Dew and fog contain more ammonia than rain-water. Ammonia is also contained in the juices of most plants, as the birch, beetroot. It is the chief source of the nitrogen in plants, and is generally evolved during their decomposition. It is abundantly produced during the putrefaction of animal matter, and, in combination with phosphoric and hydrochloric acids, exists in urine. Urea (which is isomeric with cyanate of ammonia) is readily decomposed into carbonate of ammonia and water. Some of its salts, as the carbonate and nitrate, are contained in mineral springs, as in those of Grieswolde and Kissingen; the hydrochlorate and sulphate (Mascagnin) are found in the neighbourhood of volcanoes and near ignited coal-seams. Dr Austin ascertained that if nascent hydrogen were presented to gaseous nitrogen, ammonia was formed. (Phil. Trans., vol. lxxvii. p. 379.) M. C. S. Collard has also some time since (Jour. de Chim. Méd., iii. 516) pointed out that this gas is formed during the contact of water and air wherever nascent hydrogen and nitrogen come in contact; and that thus it is produced daily in immense quantities, giving rise, it is supposed, by its further oxidation, to the nitrates which stimulate vegetable life. (*Dict. de Mat. Med.*, Merat & De Lens, i. p. 255). The metals give rise to ammonia by their deoxydation of dilute nitric acid (see p. 70); and thus it is that a small quantity of ammonia is always found in the rust found upon iron exposed to the air.

Properties.—Ammonia is a colourless transparent gas, with a pungent suffocating odour, having alkaline and caustic properties. It browns turmeric paper, and restores vegetable blues; but these effects are transient from its volatility. Its sp. gr. is 0·59. 100 c. i. weigh 18·28 grs. By a pressure of 5½ atmospheres at 50° it was reduced by Faraday to a colourless transparent liquid of sp. gr. 0·76. Water absorbs it with very great rapidity, and to a great extent. (See Solution of Ammonia.) Alcohol and æther also readily dissolve it. Near any volatile acid, especially hydrochloric, it forms white fumes, composed of particles of the salt which is formed under these conditions. It supports neither respiration nor combustion. Passed over iron or copper turnings heated to redness, or when exposed to a stream of electric sparks, 2 vols. of N_3H become 4 vols., which may be proved, by detonation with oxygen, to consist of a mixture of 1 vol. of nitrogen and 3 vols. of hydrogen. Therefore, in the union of the gases to form ammonia, 4 vols. are condensed to 2.

Anhydrous ammonia, as well as ammonia in solution (see below), combines with many anhydrous metallic salts in a manner analogous to that of water of crystallisation; and with the hydrous ones by expulsion, partial or entire, of the water of crystallisation. The chlorides of calcium, copper, tin, and silver, the sulphates of zinc and copper, and the nitrates of copper and silver, form compounds of this kind with ammonia. The composition of ammonio-sulphate of copper and of ammonio-nitrate of silver, are thus respectively represented: $CuSO_4(H_4N)_2SO_4,6H_2O$, and $2H_3N,AgNO_3$.

Ammonia neutralises the strongest acids, and forms colourless salts, which are all decomposed by heat, unless the acid with which it is combined be volatile, in which case the salt sublimes. The carbonates evolve ammonia, and become converted into bicarbonate, which volatilises and slowly disappears at ordinary temperatures. The other salts of ammonia are readily recognised by the evolution of ammonia when heated with caustic potash or quicklime.

Ammonia, with water, may be considered as ammonic hydrate for $H_3N+H_2O=H_4NHO$ which corresponds to HKO.

If an amalgam of mercury and potassium be placed in a solution of hydrochlorate of ammonia, the potassium is displaced, and the mercury swells up to a great bulk, having combined with this compound metal, ammonium, H_4N. All the salts of ammonia may be referred to ammonium, and will then resemble those of potassium. Thus, hydrochlorate of ammonia is the same thing as chloride of ammonium: $H_3NHCl=H_4NCl$.

The sulphate and other oxy-salts always contain an atom of water in combination, thus: $2H_3N+H_2SO_4=(H_4N)_2SO_4$.

The reactions between *dry* ammoniacal gas and the *anhydrous* acids is instructive. With the anhydrous hydracids ordinary ammonium salts are formed—*e.g.*, dry hydrochloric acid and dry ammoniacal gas unite immediately to form chloride of ammonium, $H_3N+HCl=H_4NCl$. But with the anhydrides of the oxyacids, SO_3,SO_2, or CO_2, compounds called *ammonides* are formed: thus, dry carbonic anhydride and dry gaseous ammonia combine directly to form carbonic ammonide $(H_3N)_2CO_2$, a compound quite different from carbonate of ammonia.

Antidotes to Poisoning by the Vapour of Ammonia.—Inhalation of vapour of hot vinegar.

SOLUTION OF AMMONIA.

The investigations of Carius show that at 32° temperature, water absorbs 1050 times its volume of ammoniacal gas; and at 59° and 78°, 727 and 586 times its volume respectively. And water saturated with the gas at 60°, contains more than $\frac{1}{3}$ its weight, is increased in bulk nearly $\frac{1}{2}$, and becomes lighter. The gas escapes on exposure to the air, and heat rapidly expels it with an appearance of ebullition, and at last nothing but water remains. It has the characters given below, and freezes into an odourless gelatinous mass at about $-40°$. The following table from Carius (*Annalen der Chemie und Pharmacie*, xcix. 129), indicates the percentage by weight of ammonia in solutions of different strength at 57°, *e.g.*, 100 grains of solution of ammonia sp. gr. 0·8844, contain 36 grains of ammoniacal gas:—

Specific Gravity.	NH_3 in 100 grs. of Sol.	Specific Gravity.	NH_3 in 100 grs. of Sol.	Specific Gravity.	NH_3 in 100 grs. of Sol.
0·8844	36	0·9133	24	0·9520	12
0·8864	35	0·9162	23	0·9556	11
0·8885	34	0·9191	22	0·9593	10
0·8907	33	0·9221	21	0·9631	9
0·8929	32	0·9251	20	0·9670	8
0·8953	31	0·9283	19	0·9709	7
0·8976	30	0·9314	18	0·9749	6
0·9001	29	0·9347	17	0·9790	5
0·9026	28	0·9380	16	0·9831	4
0·9052	27	0·9414	15	0·9873	3
0·9078	26	0·9449	14	0·9915	2
0·9106	25	0·9484	13	0·9959	1

Like solutions of lime, potash, soda, baryta, &c., that of ammonia absorbs carbonic acid from the air. It combines with acids to form salts: and with oil it forms soap, in some officinal liniments. It decomposes a great many earthy and metallic salts, precipitating their oxydes, and in some cases redissolving them in an excess of ammonia. If the ammonia be insufficient to neutralise the whole of the acid, a sparingly soluble basic salt of the metal is sometimes precipitated, *e.g.*—

$$4CuSO_4 + 6H_3N + 7H_2O = 3[(H_4N)_2SO_4] + (CuSO_4,3CuO,4H_2O).$$

The same occurs with nitrate of lead and basic sulphate of alumina. But when the ammonia is in excess, the metallic oxyde in a hydrated form usually falls, and a soluble salt of ammonia is formed, thus:—

$$2(Fe_2 3SO_4) + 12H_3N + 9H_2O = 6[(H_4N)_2 SO_4]2Fe_2O_3,3H_2O.$$

In the case of the hydrated oxydes of magnesia, copper, zinc, solution occurs when the ammonia is in excess, and definite compounds are formed. Salts of zinc and silver form colourless solutions, those of copper a deep violet blue, with excess of ammonia. It is owing to this capacity for forming double salts that ammonia, chloride of ammonium, and acetate of ammonia have the power of dissolving insoluble metallic oxydes, and salts, and of preventing their precipitation. In some cases the elements of ammonia enter into the composition of the metallic salt more intimately, as, for example, when a solution of ammonia is added to one of corrosive sublimate.

1. **Liquor Ammoniæ fortior,** *P.B.* *Strong Solution of Ammonia.*

Definition.—Ammoniacal gas, NH_3 or $\mathbf{NH_3}$ dissolved in water, and forming 32·5 per cent. of the solution.

Preparation.—Mix 3 pounds of *chloride of ammonium* in coarse powder with 4 pounds of *slaked lime*, and put it into an iron bottle fitted with an air-tight iron tube. Place the bottle in a sand-bath contained in an iron pot, and heat, at first very gently, over an ordinary fire, until bubbles of condensible gas cease to escape.

Let the whole of the gas be conducted through two empty Woulff's bottles, each of the capacity of a pint, into another bottle capable of holding 3 pints, containing 22 fluid ounces of water, and in communication with a fourth bottle holding 10 fluid ounces of water. The connections must be air-tight, and the second and third bottles furnished each with a syphon safety-tube, charged with a very short column of mercury. When the process is terminated, the third bottle will contain about 43 fluid ounces of strong solution of ammonia, and the first and second about 16 fluid ounces and 10 fluid ounces respectively of a coloured ammoniacal fluid. Place this in a flask fitted with a syphon safety-tube containing a little mercury; apply heat to the flask until it is reduced to $\frac{3}{4}$ of its original bulk, and pass the gas evolved through the water contained in the fourth bottle, which at the end of the process will be nearly of the strength of the weaker solution of ammonia, and may be exactly made so by the addition of water or of strong solution of ammonia. In the above process the chlorine is transferred from the ammonium to the lime, displacing an equiv. of oxygen, which, uniting with an equiv. of hydrogen of the ammonium, forms water, while the NH_3 escapes, thus:—

$$CaO + 2H_4NCl = CaCl_2 + H_2O + 2H_3N.$$

The water distils and collects with any impurities in the first two bottles, and becomes saturated with the gas. For the sake of economy, this is displaced by heat to form the weaker solution. The bottles in which the gas is condensed should be kept at a temperature of 57°.

Solution of ammonia is manufactured on the large scale by distilling crude sulphate of ammonia with milk of lime. Mr Lawson states that a still containing 1 cwt. of the sulphate requires about 24 hours to work it off, and will produce from 60 to 70 lbs. of the strongest solution of sp. gr. ·875. (P. J. xiv. 452.)

Characters and Tests.—A colourless liquid, of characteristic and very pungent odour, and strong alkaline reaction, sp. gr. 0·891 = 32·5 per cent. of H_3N. 52·3 grains require for neutralisation 1000 gr. measures of the vol. sol. of oxalic acid. One fluid drachm contains 15·83 grains of H_3N. Diluted with four times its vol. of distilled water it does not give a precipitate with either solution of lime (absence of CO_2), oxalic acid (absence of lime), sulphide of ammonium (metallic impurities), or ammonio-sulphate of copper (absence of arsenic). When treated with excess of nitric acid, it is not rendered turbid by nitrate of silver (absence of chlorides), nor by chloride of barium (absence of sulphuric acid).

Pharmaceutical Uses.—In the preparation of Ammoniæ phosphas, Linimentum camphoræ compositum, Liquor ammoniæ, Liquor ammoniæ citratis, Spiritus ammoniæ aromaticus, Tinctura opii ammoniata.

2. **Liquor Ammoniæ**, *P.B.* *Solution of Ammonia.*

This is made by diluting the last with 2 parts, by measure, of water.

Tests.—Sp. gr. 0·959, and it is composed of 10 parts, by weight, of ammonia and 90 of water. (See table.) 85 gr. by weight require for neutralisation 500 measures of volumetric solution of oxalic acid. One fluid drachm contains 5·2 grains of ammonia.

Incompatibilities.—Acids, acidulous and most metallic salts. Chlorine, iodine, and bromine, all of which form explosive compounds with ammonia, the first with evolution of nitrogen (see p. 37).

Action. Uses.—Ammonia and its carbonates have a similar action, that of the uncombined ammonia being the stronger. When respired the gas is a violent irritant, and the strong aqueous solution is caustic. When diluted it acts as rubefacient externally, and as a diffusible stimulant internally, increasing the force and rapidity of the heart's action. Chemically, it is antacid, and it may be given to counteract excessive acidity of the stomach or of the urinary secretions. By virtue of its stimulant action it often acts as a sudorific. A direct stimulant action on the nervous system may be readily induced by means of the vapour applied to the nostrils, and on this account it is a valuable remedy in syncope and epilepsy, and the conditions which usually precede them. In applying smelling-salts to the nostrils of a patient in a state of insensibility, we must carefully avoid excessive irritation of the mucous membrane. To secure this we should previously ascertain on our own persons the distance at which the ammonia should be held from the nostrils, and remove the bottle during every expiration at least. Ammonia is also antiseptic. Ammonia and its carbonates are useful both as a cardiac and as a general nervous stimulant in poisoning by prussic acid, opium, and the like; in the typhous state, and in the prostration which follows snake bites. In prussic acid poisoning and impending death from syncope, 5 grs. of sesquicarbonate of ammonia, or 10 mins. of the strong solution, dissolved in 1 or 2 fluid drachms of warm water, should be injected into a vein of the arm, while artificial respiration and the use of ammonia to the nostrils are being employed. The injection of ammonia for snake bite has been strongly advocated by Professor Halford, and it has been freely used with apparent success by Australian practitioners. M. Oré and Dr Fayrer have, however, both failed to corroborate Halford's statements. Intravenous injections of ammonia have also been suggested in collapse from blood-poisoning in malignant pustule, typhus, &c. M. Colin has used it in the former disease, but without success. He has, however, arrived at one important and unexpected conclusion, that as much as 45 grains of solution of ammonia can be tolerated in the veins of man. It might have been supposed that the direct introduction of so much ammonia into the blood was a dangerous proceeding, but this does not appear to be the case. It may be inferred, however, from the reports of the cases in which intravenous injections have been employed, that much damage has sometimes been done to the connective tissue. Those, therefore, who use the method must take the most scrupulous care to avoid the injection of the connective tissue with the remedy, or violent irritation and sloughing may result. Whether ammonia may be regarded as an antidote to animal poisons is doubtful; but it is certain that its immediate application to parts stung by wasps, bees, and other insects, gives speedy relief and prevents excessive swelling. As an antispasmodic, ammonia is serviceable in hysteria, epilepsy, and in flatulency. It may be given with advantage in the lithic acid diathesis, in gout and rheumatism. In bronchitis it is expectorant and diaphoretic. It should be avoided in fevers and low disorders, where there is a tendency to alkalinity or excessive fluidity of the blood. It is contra-indicated in scurvy and hæmorrhage; and where there are symptoms of gastro-intestinal irritation, viz., vomiting and purging, or excessive diaphoresis. For long use it is less objectionable than potash or soda, but, like them, tends to waste the tissues by dissolving albuminous compounds. The excessive use of ammonia or its carbonate produces vomiting, diarrhœa, and diuresis.

As an external application, ammonia may be applied in the form of the following liniment and ointment.

Dose.—10 to 30 minims in water, camphor mixture, milk, or any demulcent liquid.

Antidotes.—Vinegar, Lemon juice, or Vegetable acids.

Pharmaceutical Uses.—In the preparation of Hydrargyrum ammoniatum, Linimentum ammoniæ (1 vol. in 4).

3. **Linimentum Ammoniæ,** *P.B. Liniment of Ammonia.*

Preparation.—Agitate together 1 fluid ounce of *solution of ammonia* and 3 fluid ounces of *olive oil.*

A solution of soap is thus formed.

Rubefacient, stimulant.

4. **Ammoniacal Ointment.**

This is formed by rubbing up ammonia with fatty matter in proportions according to the effect required. If rubbed on the skin, and the ammonia allowed to evaporate, rubefaction will be produced, but if confined by a compress, vesication will ensue.

5. **Spiritus Ammoniæ Fœtidus,** *P.B. Fœtid Spirit of Ammonia.*

Preparation.—Break 1½ ounce of *assafœtida* into small pieces and macerate it in a closed vessel with 15 fluid ounces of *rectified spirit* for 24 hours, then distil off the spirit, mix the product with 2 fluid ounces of solution of *ammonia*, and add sufficient rectified spirit to make 1 pint.

Action.—Stimulant and antispasmodic. Used in hysteria and other nervous disorders of women.

Dose.—½ to 1 fluid drachm, well diluted.

CARBONATES OF AMMONIA or AMMONIUM.

Three carbonates of ammonia are known.

1. *The simple* or *normal ammonic carbonate* [$(H_4N)_2CO_3$] is only

known in solution. No matter in what proportions they are mixed, dry ammoniacal gas and carbonic anhydride combine in the proportion of 2 vols. of the former and 1 vol. of the latter, to form white solid ammonic carbamate, thus, according to Gerhardt: $2H_3N + CO_2 = H_4NH_2N,CO_2$. In the presence of water this is rapidly converted into simple carbonate: $H_4NH_2NCO_2 + H_2O = (H_4N)_2CO_3$.

2. *The sesquicarbonate*, which is the carbonate of the Pharmacopœia.
3. *The bicarbonate* or *hydro-ammonic carbonate.*

The simple carbonate is contained in the following preparation, the other two are subsequently described. The sesquicarbonate (common carbonate of ammonia) is a solid salt; and the bicarbonate of ammonia forms as an efflorescence on the latter.

1. **Spiritus Ammoniæ Aromaticus**, *P.B. Aromatic Spirit of Ammonia. Spirit of Sal Volatile.*

Preparation.—Mix together 8 ounces of *carbonate* (*sesquicarbonate*) *of ammonia*, 4 fluid ounces of strong *solution of ammonia*, 4 fluid drachms of *volatile oil of nutmeg*, 6 fluid drachms of *oil of lemon*, 6 pints of *rectified spirit*, and 3 pints of *water*, and distil 7 pints.

As the common carbonate (see below) is a sesquisalt, containing 2 equivs. of ammonia to 3 of carbonic acid, another equiv. of ammonia is presented to it and the neutral carbonate formed. The result of this mode of preparation, and the use of the volatile oils instead of the raw spices, is a more elegant and efficient medicine, stronger than the spirit of the P.L., which turned brown from the presence of oil of cloves.

Characters and Tests.—A colourless, fragrant, spirituous, and ammoniacal liquid of sp. gr. 0·870. It is not discoloured by keeping, and forms a copious milky turbidity with water, due to the separation of volatile oil.

Dose.—$\frac{1}{2}$ to 1 drachm. It may be prescribed with sulphate of magnesia.

Preparations in which it is employed.—Tinctura Guaiaci ammoniata and Tinctura Valerianæ ammoniata.

Ammoniæ Sesquicarbonas: $2NH_4O,3CO_2 = 118$ or $2(H_4N)_2O,3CO_2 = 236$. F. *Sal Volatile. Carbonate d'Ammoniaque.*

The sesquicarbonate, called simply carbonate of ammonia in the B. P., has long been known by various names, as *volatile* or *smelling salts*,* *salt of hartshorn, volatile salt of urine*, all of which indicate either its properties or the sources from whence it was obtained. It is now obtained by the action of the alkaline or earthy carbonates on chloride of ammonium, or sulphate of ammonia.

Preparation.—Either of these ammoniacal salts are reduced to powder, mixed with twice their weight of chalk, and sublimed into leaden vessels. The crude product is resublimed at 149°, and the salt condensed in leaden hoods. In this process double decomposition takes place, the acids exchanging bases, thus when chloride of ammonium is used:—$6H_4NCl + 3CaCO_3 = 3CaCl_2 + 3[(H_4N)_2CO_3]$,—simple carbonate of ammonia. But the simple carbonate is decomposed at the temperature required for the sublimation, and converted into sesquicarbonate; an equivalent of oxyde of ammonium, separating into water and gaseous ammonia which is evolved during the whole of the process:—$3[(H_4N)_2CO_3] = 2(H_4N)_2O,3CO_2 + H_2O + 2H_3,N$. The chloride of calcium remains in the retort. If sulphate of ammonia have been used in the preparation of the sesquicarbonate, sulphate of lime is the remainder.

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* The best *smelling* salts consist of the neutral carbonate, which may be made by adding to the sesquicarbonate half its weight of strong solution of ammonia.

Sesquicarbonate of ammonia is, according to the above formula, composed of 2 equivs. of oxyde of ammonium and 3 equivs. of carbonic acid, and 100 parts contain 55·93 of carbonic acid and 44·07 of oxyde of ammonium; or 28·81 of ammoniacal gas and 15·26 of water (Phillips).

Properties.—Usually met with in fragments of colourless translucent cakes, from one to two inches thick; the texture being crystalline and fibrous, and the fractured surface presenting a striated appearance; taste sharp, alkaline, ammoniacal; odour pungent, penetrating. On exposure to the air it loses its translucency, becomes friable, and converted into a white powder, which is bicarbonate of ammonia, formed by the continual escape of carbonic ammonide, thus:—

Sesquicarb. Ammonia.		Bicarb. Amm.	Carbonic Ammonide.
$2(H_4N)_2O,3CO_2$	becoming	H_4NH,CO_3 +	$(H_3N)_2CO_2$.

This salt is completely dissipated by heat; is soluble in 4 times its weight of cold water. Boiling water decomposes it with the evolution both of carbonic acid and ammonia. It is sparingly soluble in rectified spirit. Treated with a small quantity of cold water, a solution of carbonate of ammonia is obtained, while a mass of less soluble bicarbonate remains, having the form and dimensions of the sesquicarbonate employed.

Ammoniæ Carbonas, *P.B.* *Carbonate of Ammonia.*—This is the sesquicarbonate above described. A volatile and pungent ammoniacal salt produced by submitting a mixture of sulphate of ammonia or chloride of ammonium and carbonate of lime to sublimation.

The *sulphate of ammonia*, from which the sesquicarbonate is often prepared on a large scale, is obtained by neutralising *gas liquor* or *bone spirit* (impure solutions of carbonate of ammonia, see p. 116) with sulphuric acid, and it is therefore contaminated with volatile tarry and oily matters, and in the sublimation with chalk these may be driven off and condensed in the sesquicarbonate, giving it a brown colour.

Character and Tests.—In translucent (absence of bicarbonate) crystalline masses, with a strong ammoniacal odour and alkaline reaction, soluble in cold water, more sparingly soluble in spirit, completely dissipated by heat, readily soluble in acids with effervescence (carbonic acid). An aqueous solution slightly supersaturated with nitric acid and boiled (to expel carbonic acid) gives no precipitate with chloride of barium or nitrate of silver (absence of sulphates and chlorides, especially of sulphate and chloride of ammonium); 50 grains dissolved in 1 fluid ounce of water are neutralised by 1000 gr. measures of the volumetric solution of oxalic acid; 20 grains neutralise 23½ grains of citric acid, and 25½ grains of tartaric acid, respectively.

Action. Uses.—(See p. 110). Sesquicarbonate of ammonia is sometimes employed for making effervescing draughts; 20 grains saturate about 6 drachms of lemon juice.

Dose.—2 to 10 grains in solution.

Incompatibilities.—Acids, acidulous salts, alkalies, lime water, magnesia; most metallic salts, but not the potassio-tartrate, or ammonio-citrate of iron, or sulphate of magnesia.

Pharmaceutical Uses.—The salt is employed in the preparation of Liquor ammoniæ acetatis, Spiritus ammoniæ aromaticus, and the following:—

1. **Solution of Carbonate of Ammonia**, *P.B.*—Composed of ½ ounce of crystalline fragments of the sesquicarbonate dissolved in 10 ounces of water. It is used as a test.

Ammoniæ Bicarbonas. *Hydro-ammonic Carbonate.*

$H_4NO,HO,2CO_2=79$ or $\mathbf{H_4NHCO_3}=79$.

Bicarbonate of ammonia is formed whenever the sesquicarbonate is exposed to the atmosphere, or even when the bottle in which it is kept is frequently opened. It is prepared in the form of powder by exposing finely powdered sesquicarbonate to the air for 24 hours in a thin layer (see above); and in the crystalline condition by pouring boiling water upon the sesquicarbonate, closing the vessel air tight, and allowing the whole to cool, when bold rhombic prisms of bicarbonate are formed. The crystals are usually six-sided prisms, and require 8 parts of cold water for their solution. If the solution be heated carbonic acid escapes. When exposed to the air, the dry salt slowly volatilises. It should therefore be kept cool, and in a well-stoppered bottle. The ammoniacal qualities are less marked in this salt than in the sesquicarbonate, owing to the greater proportion of carbonic acid contained in it, and it has on this account been called "*mild carbonate of ammonia.*"

Tests.—Its solution at first occasions no precipitate with chloride of barium or chloride of calcium; after a short time, however, the mixture evolves carbonic acid, and a white earthy carbonate is precipitated. But it does not precipitate sulphate of magnesia.

Action. Uses.—Antacid, Diaphoretic. Being milder, it may be more suitable than the sesquicarbonate in some cases.

Dose.—5 to 20 grains in *cold* water. For effervescing draughts 20 grains will saturate 18 grains of citric or 19 grains of tartaric acid.

LIQUOR AMMONIÆ ACETATIS, *P.B.* *Solution of Acetate of Ammonia. Spirit of Mindererus.*

Acetate of ammonia ($H_4NOC_4H_3O_3=77$ or $H_4NC_2H_3O_2=77$) may be obtained in crystals in the exhausted receiver of an air-pump; but as it is a deliquescent salt, it occurs in the Pharmacopœia only in the state of solution.

Preparation.—Reduce 3¼ ounces of *carbonate of ammonia* to powder, and add it, or a sufficiency, to 10 fluid ounces of *acetic acid*, until a neutral solution is formed; then add 2½ pints of *water.*

The acetic acid combines with the ammonia, and the CO_2 escapes with effervescence.

Characters and Tests.—A colourless liquid, of sp. gr. 1·022, with a faint acetous smell and saltish ammoniacal taste. Does not alter the colour of either litmus or tumeric paper. It is not coloured by the addition of hydrosulphuric acid, showing the absence of any metallic oxyde, especially copper or lead; if diluted with water, no precipitate on addition of nitrate of silver or chloride of barium—the first indicating absence of hydrochloric, and the second of sulphuric acid. The water being evaporated, the residue yields ammonia, which is dissipated by heat; any further residue is an impurity, as both the acetic acid and the ammonia are volatile.

Incompatibilities.—The strong acids; potash, soda, and their carbonates; and lime water and magnesia.

Action. Uses.—As a refrigerant saline in fever and inflammation. Diaphoretic and Diuretic. Diluted with 10 parts of water, it may be prescribed as a local stimulant in chronic ophthalmia. Mixed with 7 parts of water and 3 of rectified spirit, it forms a useful refrigerant lotion.

Dose.—2 to 6 fluid drachms every 3 or 4 hours, in camphor mixture, or some other aromatic water.

LIQUOR AMMONIÆ CITRATIS, *P.B.* *Solution of Citrate of Ammonia.*

Citrate of ammonia ($3H_4NO,C_{12}H_5O_{11}$ or $3H_4N,C_6H_5O_7$) dissolved in water.

Preparation.—Dissolve 3 ounces of *citric acid* in 1 pint of *water*, and add 2¾ fluid ounces, or a sufficiency, of *strong solution of ammonia*, until the liquid is neutral to test papers.

Its chemical reactions are those of citric acid and ammonia, and its incompatibilities are those of acetate of ammonia. It is an excellent saline diaphoretic in feverish attacks, and as an antacid in rheumatic fever. It is more pleasant than the acetate, but it is less efficient as a diaphoretic.

Dose.—From 2 to 6 fluid drachms.

AMMONII CHLORIDUM, *P.B.* $NH_4Cl=53{\cdot}5$ or $NH_4Cl=53{\cdot}5$.

Chloride of Ammonium. Hydrochlorate or *Muriate of Ammonia. Sal-ammoniac.* F. *Hydrochlorate d'Ammoniaque.* G. *Salmiak.*

This salt was known to Geber. Avicenna and Serapion mention it by the name *Noshadur.* Persian writers give *Armeena* as its Greek synonym. The Sanscrit name is *Nuosadur;* Dr Royle obtained it by this name in India, where it is formed in brick-kilns (See Hindoo Med. p. 40). In Egypt it is obtained from the dung of camels. That it was known to the Romans, is evident from Pliny's statement that one of the kinds of *Nitrum* gives out a strong smell when mixed with quick-lime.

Preparation.—1. By neutralising *hydrochloric acid* with *ammonia,* and evaporating it to dryness. 2. The chief sources of chloride of ammonium in this country are the waste products formed in the preparation of animal charcoal (see p. 95) and of coal gas. In both cases an ammoniacal fluid condenses,—formed, in the first, from the nitrogenous constituents of bones or other refuse animal matter; and, in the second, from the nitrogen of the fossil vegetable matter. In the distillation of coal, the nitrogen is for the most part converted into ammonia, which combines with the carbonic acid and sulphuretted hydrogen simultaneously formed in the process, and thus accumulates in the offensive tarry and *ammoniacal liquor.* On neutralising this with hydrochloric acid, the carbonate and sulphide of ammonium are converted into chloride with the evolution of an abundance of carbonic acid and sulphuretted hydrogen gases. The fluid is concentrated to the crystallising point: the impure crystals are separated and first roasted, to expel tarry matter, and then sublimed in an iron pot furnished with a leaden or iron cover lined with fire-clay, upon the inner surface of which the salt is deposited in the form of a large, dome-shaped cake, about four inches thick. If HCl does not happen to be a waste product (see p. 150) in the chemical works, the manufacturer may find it cheaper or more convenient to use sulphuric acid in the neutralisation of the "*bone spirit;*" and in this case a crude sulphate of ammonium is formed On mixing this with common salt and subliming, sal-ammoniac condenses, thus: $(H_4N_2)SO_4+2NaCl=Na_2SO_4+2NH_4Cl$. (For a full account of the manufacture of ammonia and its salts, see Pharmaceutical Journal, vol. ii.)

Characters and Tests.—In colourless, inodorous, translucent, fibrous masses, usually pieces of hollow, hemispherical cakes, sp. gr. 1·45, tough and difficult to powder, soluble in water (100 parts at 59° dissolves 36, and at 212° 88·9 parts of the salt), with a great reduction of temperature. It separates from a hot saturated solution in cubes, octohedra and tetrahedra. It is soluble in 5 parts of alcohol, and in less of rectified spirit. The aqueous solution, when heated with caustic potash, evolves ammonia; and when treated with nitrate of silver, forms a copious curdy white precipitate (AgCl), soluble in ammonia. When heated it volatilises without decomposition, and leaves no residue.

Chloride of ammonium forms double salts with the chlorides of several metals; and the arseniates arsenites, antimoniates, and stannates, when heated with it form chlorides of arsenic, antimony, and tin. Salts of lead, iron, zinc, and aluminium are also decomposed and completely volatilised when ignited with a large excess of sal-ammoniac.

Impurities.—1. Chloride of calcium; this makes the salt slightly deliquescent on the surface, and causes a precipitate with oxalate of ammonia. 2. Traces of iron and lead are sometimes present, derived from the iron or leaden hood in which the salt is condensed. The former is often conspicuous as a rusty stain on the convex surface of the crystalline mass. 3. Sulphate of ammonia is an occasional impurity, owing to want of care in the sublimation of the chloride from this salt. To the above tests we may therefore add the following: the aqueous solution is not discoloured by hydrosulphuric acid (absence of iron and lead), and gives no precipitate with chloride of barium (absence of sulphate).

Incompatibilities.—See characters of the Salts of Ammonia, p. 121. Soluble salts of lead precipitate the chlorine.

Action and Uses.—Like the other salts of ammonia, the chloride possesses a *general stimulant action*, inducing increased secretion from the mucous membrane and skin; and this effect has been extended by some observers to the parenchymatous glands. It has, therefore, been recommended as a substitute for mercury in removing inflammatory or syphilitic exudations. It appears to have afforded relief in chronic catarrh of the pulmonary and vesical mucous membrane, and in chronic enlargement of the mesenteric glands and spleen, the uterus, ovaries, and prostate. The idea that sal-ammoniac has a *sedative influence on the nervous system* seems to be taking possession of the medical mind, some authors stating that it is efficacious in pure neuralgia, in headache, epilepsy, and even in mania.

Externally it may be used as a refrigerant in the proportion of 1 part to 10 of water. A mixture of four ounces each of sal-ammoniac and nitre in powder, with 8 ounces of water, reduces the temperature from 50° to 10°. This mixture, contained in a bladder, or better, in an india-rubber bag, may be employed where great cold is needed. Care is required in its use, or the rednction of the temperature of the part to which it is applied may become too great.

Dose.—From 5 to 30 grains, in the form of lozenge or mixture.

Pharmaceutical Uses.—In the preparation of Liquor hydrargyri perchloridi, and as a test in the following form:—

1. Solution of Chloride of Ammonium, 1 ounce of the salt dissolved in 10 fluid ounces of water.

Ammoniæ Sulphas, $NH_4O,SO_3=66$ or $(H_4N)_2SO_4=132$.—This salt is prepared from gas liquor, as above stated. It may be used in the purification of sulphuric acid.

AMMONIÆ NITRAS, *P.B.* *Nitrate of Ammonia.*
$H_4NO,NO_5=80$ or $H_4NNO_3=80$.

Prepared by neutralising dilute nitric acid with sesquicarbonate of ammonia, evaporating the solution until crystals are formed, and keeping these fused at a temperature not exceeding 320°, until the vapour of water is no longer emitted.

By evaporation of the solution below 100°, the salt crystallises in fine six-sided prisms, terminated by six-sided pyramids, containing 4 equivs. of water of crystallisation. If the solution be boiled down, the nitrate is obtained in either a fibrous or amorphous mass, but still containing water of crystallisation. Both of these varieties fuse at a lower temperature (below 300°) than the anhydrous salt, and between 360° and 400° boil, giving off steam without undergoing decomposition.

Characters and Tests.—A white deliquescent salt, in confused crystalline masses, having a bitter acrid taste. Soluble in less than its own bulk of water, with great depression of temperature; sparingly soluble in rectified spirit. A solution of one part in eight of water gives no precipitate with solution of nitrate of silver or of chloride of barium (absence of ammonic chloride and sulphate). Heated with caustic potash, it evolves ammonia (*e.g.*, test of a salt of ammonia); with sulphuric acid, it emits nitric acid vapour. It fuses at 320°, and at 350° to 450° it is entirely resolved into nitrous oxyde gas, NO or N_2O, and the vapour of water.

Used for the production of nitrous oxyde (see p. 73).

AMMONIÆ PHOSPHAS, *P.B.* *Phosphate of Ammonia.*
$2H_4NO,HO,PO_5=132$ or $(H_4N)_2HPO_4=132$.

Preparation.—Add *strong solution of ammonia* to 20 fluid ounces of *dilute phosphoric acid* until the solution is slightly alkaline, then evaporate the liquid, adding more ammonia from time to time, so as to keep it in slight excess, and when crystals are formed, on the cooling of the solution, dry them quickly on filtering paper placed on a porous tile, and preserve them in a stoppered bottle.

Characters and Tests.—Phosphate of ammonia forms transparent colourless prisms, which effloresce if long exposed, losing water and ammonia; soluble in water, insoluble in rectified spirit. Heated with potash, it evolves ammonia. The aqueous solution gives a light yellow precipitate with nitrate of silver (Ag_3PO_4). If 20 grains be dissolved in water, and solution of ammonio-sulphate of magnesia added, there is a crystalline precipitate (ammonio-phosphate of magnesia), which, when washed with solution of ammonia, dried, and heated to redness, leaves 16·8 grains (dimagnesic phosphate, see p. 66).

The commercial salt is usually prepared from the acid phosphate of lime formed by the action of sulphuric acid on bone-earth (see p. 62), in which case it is contaminated with a little sulphate of ammonia. The impurity is readily detected by chloride of barium.

Action. Uses.—Phosphate of ammonia has been recommended in the lithic-acid diathesis, gout, and rheumatism. It is supposed to decompose the insoluble lithate of soda in the system, forming lithate of ammonia and phosphate of soda. It is said to diminish gouty concretions, and prevent gravel.

Dose.—10 to 20 grains, or more.

AMMONIÆ BENZOAS, *P.B.* *Benzoate of Ammonia.*

$NH_4O,C_{14}H_5O_3 = 139$ or $NH_4C_7H_5O_2 = 139$.

Preparation.—Dissolve 2 ounces of *benzoic acid* in 3 fluid ounces of *solution of ammonia*, previously mixed with 4 fluid ounces of *water;* evaporate at a gentle heat, keeping the ammonia in slight excess, and set aside that crystals may form.

Characters and Tests.—In colourless laminar crystals, soluble in water and spirit; sublimes without residue. Its aqueous solution, heated with potash, evolves ammonia; and, if it be not too dilute, it deposits benzoic acid when acidulated with hydrochloric acid. With persalts of iron it gives a bulky, yellowish precipitate (benzoate of peroxyde of iron).

Action. Uses.—It is a diuretic, and renders the urine acid. In its passage through the body it is decomposed, and the benzoic acid is converted into hippuric acid, in which form it is excreted. It would appear that benzoic acid, in its way through the liver, combines with an equivalent of glycocin, since glycocin ($C_2H_5NO_2$), and benzoic acid ($C_7H_6O_2$) = hippuric acid ($C_9H_9NO_3$) + H_2O, and hippuric acid splits into glycocin and benzoic acid when boiled with strong hydrochloric acid. Kühne states that benzoic acid passes unchanged through the body in patients who have disease of the liver. Hippuric acid is a large and constant constituent of the urine of herbivorous animals. It has further been supposed that the benzoates decompose or dissolve uric acid and its compounds. They are, however, of most use in cases of inflammation with mucous discharge from the bladder, where the urine is alkaline and deposits earthy phosphates.

Dose.—5 to 30 grains.

AMMONIÆ OXALAS. *P.B.* *Oxalate of Ammonia.*

$2H_4NO,C_4O_6 + 2HO = 142$ or $(H_4N)_2C_2O_4,H_2O = 142$.

Preparation.—Oxalate of ammonia is directed to be prepared as follows:—Dissolve 1 ounce of purified *oxalic* acid in 8 fluid ounces of *water;* neutralise with *carbonate* (sesquicarbonate) *of ammonia* at a boiling temperature; filter while hot, and set by, that crystals may form in the cold.

Characters and Tests.—Colourless prisms, resembling Epsom salts; heated with potash, ammonia is evolved. The aqueous solution gives a copious, fine, white, sandy precipitate, in neutral or alkaline solutions of salts of lime. Completely dissipated by heat.

Use.—To form the **Solution of Oxalate of Ammonia** ($\frac{1}{2}$ ounce of the salt to 1 pint of water), which is employed in detecting the presence of lime.

The solution to be tested should be first carefully neutralised with ammonia, and a small quantity of a solution of chloride of ammonia added. Then, on the addition of the oxalate, a white precipitate of calcic oxalate ($CaC_2O_4,2H_2O$) will form if any lime is present, but solutions containing magnesia will be unaffected.

SOLUTION OF SULPHIDE OF AMMONIUM, *P.B.*

$H_4NS = 34$ or $(H_4N)_2S = 68$.

Preparation.—Pass a stream of washed *sulphuretted hydrogen* through 3 fluid ounces of *solution of ammonia*, so long as the gas continues to be absorbed; then add to it 2 fluid ounces more of solution of ammonia, and preserve the fluid in a green glass bottle furnished with a well-ground stopper. When solution of ammonia is saturated with sulphuretted hydrogen, hydrosulphate of ammonia, or sulphydrate of ammonia, H_4NS,HS or H_4NHS, is formed; and on adding another equiv. of ammonia (ammonic hydrate), this is converted into proto-sulphide, thus: $H_4NHS + H_4NHO = (H_4N)_2S + H_2O$.

Characters.—A colourless solution, smelling strongly of ammonia and sulphide of hydrogen, and becoming yellow on exposure to air and light, from the formation of disulphide and hyposulphite of ammonia, due to the absorption of oxygen.

Uses.—Sulphide of ammonium is used for the detection and separation of certain metals. On account of a tendency to the formation of double soluble sulphides. many of the sulphides which are insoluble in water are freely dissolved by sulphide of ammonium.

The following table represents the behaviour of sulphide of ammonium with the metallic compounds, treated of in this work:—

1. No precipitate with salts of	2. A precipitate, soluble in excess with salts of	3. A precipitate, insoluble in excess with salts of
Ammonia.	Antimony (orange red).	Aluminium (white).
Barium.	Arsenic (yellow).	Bismuth (black).
Calcium.	Gold (brownish black).	Cadmium (bright yellow)
Cerium.	Platinum (brownish-black).	Chromium (green oxyde).
Lithium.	Tin peroxyde (yellow).	Copper (black).
Magnesium		Iron (black).
Potash.		Manganese (flesh-coloured).
Soda.		Mercury (black, or becoming so).
Strontium.		Silver (black).
		Tin protoxyde (black).
		Zinc (white).

Excepting the compounds of the metals of the alkalies and earths (all but alumina), sulphide of ammonium precipitates from a neutral solution those metallic bases which are not precipitated by sulphuretted hydrogen from an acid solution (see p. 60).

Characters of the Compounds of Ammonium.—When combined with a volatile acid they sublime unchanged; otherwise they are all decomposed by heat. Potassic carbonate causes no precipitate. Heated with the caustic alkalies or lime, or their solutions, the solid salts, or their solutions, evolve free ammonia. Nessler's solution* gives a brown tinge, or a brown precipitate, when added to solutions (free from sulphides or cyanides of the metals of the alkalies) containing a faint trace of ammonia.

Platinic perchloride precipitates the whole of the ammonia as a yellow insoluble double salt ($2H_4NCl,PtCl_4$), which contains in 100 parts 7·62 of ammonia. Heated to redness it is decomposed, only spongy platinum remaining, by which it is distinguished from the corresponding potassium salt (see below, "Salts of Potassium").

POTASSIUM: $K = 39$ or $\mathbf{K} = 39$.

F. *Potassium.* G. *Kalium* and *Kali Metall.*

Potassium is the metallic base of potassa or potash. In combination it exists in nature in abundance, united with acids and earths, iodine, bromine, &c.; but it is obtained chiefly from the vegetable kingdom. It was discovered by Davy in October 1807. He separated it from a fragment of slightly moistened caustic potash by the action of a powerful voltaic battery, when the metal in small globules appeared at the negative pole. It is now commonly obtained by exposing carbonate of potash to intense heat with charcoal, which removes its oxygen, and thus sets the potassium free.

Properties.—Potassium at 55° is a soft malleable solid. It has been crystallised in cubes, is brittle at 32°, fuses at 156°, and distils at a full reddish-white heat; at 60°, its sp. gr. is 0·86. It is therefore light enough to float on water. It is silvery white, but immediately tarnishes when exposed to air, from its great affinity for oxygen, which it will take also from water, swimming and burning upon it with great brilliancy, and being converted into potash, while an equivalent portion of hydrogen escapes. It is preserved in fluids, such as petroleum and naphtha, which contain no oxygen, as it is one of the most powerful deoxidising agents known. From the affinity of potassium for oxygen, the oxyde, potash proper, or dipotassic oxyde (KO or $\mathbf{K}_2\mathbf{O}$) is readily formed by exposing the metal to dry air or to oxygen gas.

Characters of the Salts of Potassium.—Colourless, with a colourless acid: several are deliquescent; give a purple tinge to flame. In moderately concentrated solutions; excess of tartaric acid in solution causes, with brisk stirring, a colourless crystalline precipitate of cream of tartar, readily soluble in excess of alkali; with platinic perchloride, a yellow crystalline precipitate ($2KCl,PtCl_4$) insoluble in alcohol and æther, but slightly soluble in cold water. This last precipitant is the means of estimating the amount of potassium in solution. Both solutions should be concentrated, and that of the potassium salt acidulated with HCl. A slight excess of platinic chloride is then added, and the mixture is evaporated to dryness on a water-bath, and the residue washed with alcohol so long as anything is dissolved. The salt is now heated to redness, when the platinum loses its chlorine, and only spongy platinum and chloride of potassium remain. The latter may be dissolved out, dried, and estimated. 100 parts of the salt correspond to 19·26 K_2O, or 15·98 of potassium.

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* It is thus prepared. To an aqueous solution of *perchloride of mercury* add *iodide of potassium* until the mercuric iodide is nearly dissolved; then pour into the filtered liquid solution of caustic potash, set by, and decant the clear fluid. With a salt of ammonium, an insoluble brown hydrarg-ammonium iodide, or ammonium iodide, in which 4 atoms of hydrogen are replaced by 2 of mercury ($\mathbf{Hy_2N,I.H_2O}$), is formed.

POTASSA CAUSTICA or **POTASH**, *P.B.* *Potassic Hydrate*, KO,HO = 56 or KHO = 56.

Potassa. Potassa fusa. Oxyde of Potassium. Potassæ Hydras. Fixed Vegetable Alkali. F. *Potasse caustique.* G. *Aetzkali.*

Caustic potash contains in 100 parts 83·94 of oxyde of potassium (KO or K_2O), and 16·06 of water (HO or H_2O). The name *potassa* was derived from the commercial name potash, which is applied to the crude carbonate. Dr Black, in 1756, first clearly distinguished the carbonate from the caustic alkali. This he called *lixivia*, from the name in Pliny; but it was afterwards named *kali.* The ancients were, no doubt, acquainted with some method of depriving the alkali of its carbonic acid, as they were skilled in the art of making soap. (Pliny, xxviii. c. 51). It has so great an attraction for water, that it readily absorbs it from the air, and becomes converted into the hydrate, from which it is impossible to expel the water by any degree of heat.

Preparation.—Dissolve *carbonate of potash* in 10 parts of *water*, and boil in a clean iron or silver vessel, and add to the boiling solution a quantity of *caustic lime* equal in weight to half the potassic carbonate used. Calcic carbonate is precipitated, and potassic hydrate remains in solution, $K_2CO_3 + CaH_2O_2 = 2KHO + CaCO_3$. The lime should be freshly slaked, made into a paste with water, and added in small quantities, so as not to stop the boiling. The vessel should now be tightly covered and set aside until the calcic carbonate has completely subsided. The clear solution is then decanted, and rapidly boiled down in a clean iron or silver pan until there remains a fluid of oily consistence, a drop of which when removed on a warm glass rod solidifies on cooling. Pour this into proper moulds, and when it has solidified, and while it is still warm, put it into stoppered bottles. If caustic potash be required absolutely pure it should be made, as above described, from pure crystals of bicarbonate of potash and lime obtained from black marble.

Characters.—In hard, white, broken plates or in pencils; sp. gr. 2·2. It melts below redness, forming an oily liquid as clear as water, and volatilises at a full red heat in white caustic vapours; absorbs water and carbonic acid very rapidly from the air; powerfully alkaline, decomposing the fatty compounds, and forming soaps with their acids, and neutralising the most powerful acids. At a high temperature it decomposes even the silicates, and by uniting with silicic acid renders it soluble. Many metals are oxydised when fused with it; and the oxydes of other metals, those of arsenic, antimony, chromium, and manganesium, are converted into acid oxydes which unite with the potash (*e.g.*, manganate of potash). It unites directly with sulphur, phosphorus, chlorine, iodine, and bromine (see pp. 80, 86, &c.). Its aqueous solution decomposes most metallic salts, precipitating from solution all metals which form insoluble oxydes or hydrates. It is powerfully corrosive, decomposing both animal and vegetable tissues; and precipitates from vegetable infusions their alkaloids or neutral principles, some of which (atropia and daturia), it speedily decomposes, and renders them inert. The precipitates which it forms in solutions of salts of aluminium, glucinum, chromium, zinc, and lead, are soluble in excess of the alkali; but all the others are insoluble. On account of its solvent action of oxyde of lead it corrodes English flint glass, and should therefore be preserved in green glass bottles. As glass stoppers are apt to become fixed in the bottle, soft compressible stoppers of pure India-rubber are very useful. The vulcanised, some varieties of which contain sulphur, and others sulphide of antimony, must be carefully avoided, since both sulphur and the sulphide of antimony are soluble in caustic potash.

Tests.—It is wholly soluble in alcohol (showing absence of silicates of calcium, aluminium, iron and lead, and other impurities); completely soluble in water without effervescence (absence of peroxide of potassium, which is decomposed by water with liberation of oxygen); a dilute solution gives no precipitate with baryta water (absence of sulphates and carbonates), nor with oxalate of ammonia (freedom from lime), nor with sulphide of ammonium (freedom from iron and other metallic impurities). The P.B., however, does not object to traces of chlorides, sulphates, and other impurities; "56 grains dissolved in water leave only a trace of sediment" (usually silicates), "and require for neutralisation at least 900 gr. measures of the volumetric solution of oxalic acid." The caustic potash of the Pharmacopœia is in pencils.

As caustic potash is soluble in less than its weight of alcohol, and since the carbonates and bicarbonate of potash, the silicates and other impurities, are insoluble in alcohol, an impure preparation may be purified by solution in this fluid, and subsequent evaporation and fusion. This is the "*potasse à l'alcool*" of the French. Water dissolves nearly twice its weight of caustic potash with the extrication of much heat. Acute rhombohedra ($KHO, 2H_2O$) may be obtained from a hot saturated solution.

The following table (from Zïmmermann) shows the proportion of anhydrous potash (potassic oxyde) by weight in solutions of different densities at 59° :—

Specific gravity.	KO_2 per cent.	Specific gravity.	K_2O per cent.	Specific gravity.	K_2O per cent.
1·3300	28·290	1·1979	18·671	1·0819	8·487
1·3131	27·158	1·1839	17·540	1·0703	7·355
1·2966	26·027	1·1702	16·408	1·0589	6·224
1·2805	24·895	1·1568	15·277	1·0478	5·002
1·2648	23·764	1·1437	14·145	1·0369	3·961
1·2493	22·632	1·1308	13·013	1·0260	2·829
1·2342	21·500	1·1182	11·882	1·0153	1·697
1·2268	20·935	1·1059	10·750	1·0055	0·5658
1·2122	19·803	1·0938	9·619		

From this table the quantity of caustic potash contained in 100 parts of a solution of a given sp. gr. may be readily calculated; for as an equivalent of potassic oxyde is to an equivalent of caustic potash, so is the given quantity of potassic oxyde to the required quantity of potassic hydrate, *e.g.*, as 47 : 56 : : 6·224 : 7·41. According to this table and calculation, the liquor potassæ of the Pharmacopœia contains rather more than 7 per cent. of potassic hydrate. A solution of 1 part of the hydrate in 3 parts of water (used for the absorption of carbonic acid in analysis) would have a sp. gr. of about 1·25. Owing to its destructive action on animal and vegetable tissue, solution of caustic potash cannot be filtered except through powdered glass or sand.

Action. Uses.—Caustic potash in the solid state is used simply as a *caustic.* On account of its deliquescent character it is the most penetrating of all the escharotics, excepting perhaps sulphuric acid. On this account it is the most suitable application to parts bitten by venomous snakes and rabid animals; but, in all other cases, extreme care is necessary in applying it, otherwise the eschar will be much deeper and wider than was intended. It is only suitable for external use, and should never be applied to a mucous or serous membrane, because it is impossible to limit its action on these moist surfaces. The following is the best method of applying it to the skin, or its warty and fungous excrescences. Take a dry stick of the caustic in a crayon holder in one hand, and a folded bit of blotting paper in the other, with other pieces ready at hand. The skin, if damp, should be previously dried. Then rub the caustic on the part intended to be destroyed, keeping the end a little within the area. Sufficient moisture soon forms and rapidly increases, and it must be carefully removed by the repeated use of blotting paper. In the course of a minute or two the skin will assume a dead white opaque appearance. When this occurs remove the caustic and every trace of moisture, and then cover with a piece of adhesive plaster, or apply a poultice. The use of a ring of adhesive plaster to limit the action of the caustic is objectionable, as the edge absorbs the deliquescent caustic, and by extending the area of its action defeats the purpose it was intended to serve. It is employed in this manner to form issues, to destroy warts and other epithelial growths; to open abscesses and hydated tumours of the liver, &c., the idea (which is not borne out by experience) being that its use in these latter cases promotes adhesion of the tumour to the peritoneum, whereby the safety of the patient is so far insured.

1. **Potassa cum Calce.** *Paste escharotica Londinensis, Vienna Paste.*

Preparation.—Take 1 ounce of *hydrate of potash* and 1 ounce of *lime;* rub together, and keep in a well-closed vessel. (London Pharmacopœia).

When mixed with water it is slaked, and when an acid is added no bubbles of CO_2 should be evolved.

Action. Uses.—Caustic. It is made into a paste with rectified spirit, and applied, the neighbouring parts being defended with sticking-plaster. The lime is supposed to obviate the difficulty arising from the deliquescence of caustic potash, but it only partially does so; and when the precautions given above are used, simple caustic potash is to be preferred.

2. **Liquor Potassæ,** *P.B. Solution of Potash.*

Preparation.—Dissolve 1 pound of *carbonate of potash* in 1 gallon of *water*, and, having heated the solution to the boiling point in a clear iron vessel, gradually mix with it 12 ounces of *slaked lime;* and continue the ebullition for ten minutes, with constant stirring. Then remove the vessel from the fire; and when by the subsidence of the insoluble matter the supernatant liquor has become perfectly clear, transfer it by means of a syphon to a green-glass bottle furnished with an air-tight stopper. Add *water*, if necessary, to obtain the required sp. gr. and neutralising power.

Tests.—Sp. gr. 1·058. 1 fluid ounce (462·9 grains by weight) requires for neutralisation 482 measures of the volumetric solution of oxalic acid, corresponding to 5·84 per cent. by weight of hydrate of potash, KO,HO or **KHO**. It does not effervesce when added to an excess of diluted hydrochloric acid (absence of carbonate). Mixed with an equal volume of water it gives no precipitate with solution of lime (absence of carbonate), or oxalate of ammonia (absence of lime). Treated with excess of nitric acid and evaporated to dryness, the residue forms with water a nearly clear solution (presence of a faint trace of silica), which may be slightly precipitated by chloride of barium (a trace of sulphate) and nitrate of silver (trace of chloride); but it is unaffected, or but very slightly affected by ammonia (absence or only a faint trace of alumina). If the solution be kept in flint-glass bottles or badly glazed jars, sulphide of ammonium will produce a brown colour, showing the presence of lead.

Incompatibilities.—Acids, acidulous and ammoniacal salts, earthy and metallic salts, subchloride and perchloride of mercury. The vegetable alkaloids, and the infusions, &c., which contain them. (See Atropia).

Antidotes.—Oil, Acids, Vinegar, Lemon juice.

Action and Uses.—Liquor potassæ is a powerful *corrosive.* This is indicated by the soapy feeling caused by rubbing it between the fingers, the epidermis being softened and dissolved. This solution, and also that of the carbonate, when taken into the stomach, may induce collapse and death within twelve hours, just as occurs in poisoning with mineral acids, and from the same cause, viz., destruction, more or less extensive, of the mucous membrane of the stomach; or the patient having recovered from the immediate effects of the alkali in a concentrated form, may die some weeks after from the secondary effects of inanition due to the stricture of the gullet. Largely diluted with water, it is given internally as an *antacid* in disorders requiring an alkali; that is, in cases where there is an excess of acid in any part of the system; in acid dyspepsia; in urinary irritation due to excessive acidity; in cases of uric lithiasis and calculus; and in gouty and rheumatic disorders generally. Potash is also *antiphlogistic* in inflammations, possibly from its power in dissolving the fibrin of the blood, and thus hindering the deposit of lymph. In a similar manner it may arrest the progress of tuberculous disorders. It has been given with advantage in scrofula and syphilis.

Potash is readily absorbed by the mucous membrane, passes through the system, and will produce an alkaline state of the urine, if its use be persevered in. Its prolonged use impoverishes the blood. The carbonates of potash resemble the free alkali in their action, but are milder in direct proportion to the amount of carbonic acid which they contain. Both potash and its carbonates act as *Diuretics.*

Salts of potassium (chlorides and phosphates) exist in every fluid of the body, and they may therefore be regarded as necessary articles of diet, and when the blood is deficient in them, as *restorative.*

Dose.—10 fluid minims to 1 drachm, gradually increased, with infusion of orange peel, &c.

CARBONATE OF POTASH or POTASSIUM.

$KOCO_2=69$ or $K_2CO_3=138$.

Potassic carbonate contains in 100 parts 68·11 of K_2O, and 31·89 of CO_2, and has a sp. gr. of 2·267. It may be crystallised from a saturated solution in opaque oblique rhombic octahedra, containing 2 equivs. of water of crystallisation ($K_2CO_3,2H_2O$). It is so deliquescent that when exposed for a time to the air, it forms an oily-looking liquid, the "*oleum tartari per deliquium*" of olden times. Cold water (59°), dissolves $\frac{9}{10}$ths of its weight, and boiling water full twice its weight of the salt. It fuses at a red heat, and is partly volatilised without decomposition at a very high temperature; but when fused with silica, or minerals containing it, the carbonic acid is driven off with effervescence, and a silicate of potassium is formed.

As this salt is obtained by the burning of vegetables, it must have been known at very early times. Dioscorides describes it by the name *τέφρα κληματίνης*, or *cinis sarmentorum*, ashes of vine-twigs. (" Cineris lixivium." Pliny, xxxvii. c. 51.) The Arabs are usually supposed to have been the first to make known this alkali (al-*kali*); but the Hindoos, in works from which the Arabs copied, made use of the ashes of plants. Potash is found in most of the alkaline-earthy minerals, as mica, felspar, leucite, nacrite. Carbonate of potash has been found in a few mineral springs. It is probably found in the juices of some plants. But usually potash is combined with other acids, then forming acetates, malates, oxalates, tartrates, &c.

By incineration, the vegetable acid is burnt and decomposed, forming chiefly carbonic acid, which combines with the potash to form carbonates. This, in its most impure state, is the potash, or rough potash, of commerce. To obtain this, land plants are burnt in countries where forests are most abundant, as N. America, Russia, Sweden, Poland. The wood is piled in heaps and burnt on the surface of the ground, in a place sheltered from the wind. " The ashes which are left consist of a soluble and insoluble portion. The *soluble* part is made up of the carbonate, together with the sulphate, phosphate, and silicate of potash, and the chlorides of potassium and of sodium; and the insoluble portion, of carbonate and phosphate of lime, alumina, silica, the oxydes of iron and manganese, and a little carbonaceous matter that has escaped incineration." The ashes are lixiviated in barrels with lime, and the solution evaporated in iron pots to the consistence of brown sugar. This is the *black salt* of the American manufacturers. It is either fused and cast into cakes, which are usually of a reddish colour from peroxyde of iron, and so constituting the *potashes* of commerce; or else it is transferred to a large oven-shaped or reverberatory furnace, where the flame is made to play over it; and being well stirred about, the black impurities (carbon) are burnt out, and the mass becomes a caustic salt of a white colour with a tinge of blue, constituting the *pearlash* of commerce. (Wood and Bache.)

American potash and American pearlash, as ascertained by Vauquelin, contained in 1152 parts,

	(1)	(2)
Caustic potash, . . .	857	754
Sulphate of potash, . .	154	80
Chloride of potassium, . .	20	4
Carbonic acid and water, . .	119	308
Insoluble matter, . . .	2	6
	1152	1152

Russian potash yields 772 parts of caustic potash. For commercial purposes it is extremely necessary to ascertain the quantity of alkali contained in any specimen of commercial potash. This is done by process of alkalimetry given above under "Tests" of Liquor potassæ.

1. Potassæ Carbonas, *P.B.* *Carbonate of Potash.*

Subcarbonate of Potash. Salt of Tartar. Salt of Wormwood. Kali præparatum. F. *Carbonate de Potasse.* G. *Kohlensaures Kali.*

KO,CO_2 or K_2CO_3, with about 16 per cent. of water of crystallisation.

Preparation.—Wash *pearlash* with its own weight of water, pour off the clear solution, and evaporate it to dryness while it is kept briskly agitated.

Characters and Tests.—A white crystalline powder, alkaline and caustic to the taste, very deliquescent, readily soluble in water, but insoluble in spirit (absence of potassic hydrate), effervescing (CO_2) with diluted hydrochloric acid, and forming a solution with which perchloride of platinum gives a yellow precipitate ($2KCl, PtCl_4$). Loses about 16 per cent. of its weight (water of crystallisation) when exposed to a red heat. Supersaturated with nitric acid and evaporated to dryness, the residue is entirely soluble, excepting only a trace of silica; and the solution is precipitated only faintly by chloride of barium (trace of sulphate) and nitrate of silver (trace of chloride). 83 grains require for neutralisation at least 980 gr. measures of the volumetric solution of oxalic acid. 20 grains neutralise 17 grains of citric, or 18 of tartaric acid.

The carbonate of the Pharmacopæia thus contains 16 per cent. of water and traces of silicates, sulphates, and chlorides. A perfectly pure salt may be obtained by heating the crystalline bicarbonate to a low red heat, whereby water and an equivalent of carbonic acid are driven off. The otherwise pure carbonate obtained by igniting the neutral or acid tartrate of potash (see p. 139) may contain a little cyanide, if the salts are not completely free from nitrogen. (For the detection of this impurity see p. 104.) A pure carbonate is sometimes prepared by deflagrating a mixture of equal parts of nitrate and acid tartrate of potash; but even when these salts are pure, the product may be contaminated, if carelessly prepared, with hyponitrite and even undecomposed nitrate of potash. (For the detection of these impurities see p. 72.) With chloride of mercury a brick-red precipitate of oxyde of mercury is formed.

Incompatibilities.—Acids and acidulous salts, chloride and acetate of ammonia, lime water, chloride of calcium, sulphate of magnesia, alum, and generally the earthy and metallic salts (see Carbonates, p. 98). A white precipitate (carbonate of magnesia) is formed when this salt is added to a solution of sulphate of magnesia; as this does not take place when bicarbonate of potash is added, this sulphate is a useful test for distinguishing the one carbonate from the other.

Action.—As a medicine, carbonate of potash is a useless encumbrance of the Pharmacopæia. The quantity of carbonic acid combined with it is insufficient to mask the corrosive action of potash, and for internal use it may be taken generally to have the same action as liquor potassæ, but milder.

Uses.—It is employed in the preparation of the following articles of the Pharmacopæia:—Atropia, Decoctum aloes compositum, Enema aloes, Liquor arsenicalis, Liquor potassæ, Mistura ferri composita, Potassa sulphurata, and in that of Potassæ acetas, bicarbonas, chloras, citras, tartras.

Antidotes.—Vinegar, Oil, Lemon-juice.

Dose.—10 grains to ½ drachm.

POTASSÆ BICARBONAS, *P.B.* *Bicarbonate of Potash.*

$KO,HO,2CO_2=100$ or $KHCO_3=100$.

Hydropotassic Carbonate. G. *Doppelt Kohlensaures Kali.*
F. *Bicarbonate de Potasse.*

Bicarbonate of potash or aërated kali was first prepared by Cartheuser in 1752. It differs greatly from the foregoing in having no corrosive action. 100 parts are composed of 47·53 of KO, 43·57 of CO_2, and 8·91 of water.

Preparation.—Dissolve 1 pound of *carbonate of potash* in 2 pints of *water*, and filter the solution into a three-pint bottle, closed tightly by a cork traversed by a glass tube sufficiently long to pass to the bottom of the fluid. Place in another bottle, in the bottom of which a few small holes have been drilled, 1 pound of white marble in fragments, and close with a cork, also traversed by a glass tube. The glass tubes are then connected air-tight by means of a piece of India-rubber tubing, and *carbonic acid* is slowly and continuously evolved by placing the bottle containing the marble in a jar containing 1½ pint of hydrochloric acid, diluted with 3 parts of water. After a week numerous crystals of bicarbonate will have formed, which are to be removed, shaken with twice their bulk of cold distilled water, and after decantation of the water, drained and dried on filtering paper by exposure to the air. The mother liquor is filtered if necessary and concentrated, at a temperature not exceeding 110°, to one half, when more crystals are formed. The gas delivery-tube should be of large diameter, in order that the process may not be obstructed by the forming crystals.

In this process the saturation of the carbonate is effected under slight pressure. One equivalent of carbonate unites with an equiv. each of water and carbonic acid to form two equivalents of bicarbonate: $K_2CO_3+H_2O+CO_2=2KHCO_3$.

Characters and Tests.—Colourless and transparent right rhombic prisms, permanent in the air—not deliquescent, of a mild saline taste. It is insoluble in alcohol, soluble in about 4 parts of cold (60°) and 1 part of hot water. If the solution be boiled or exposed to the air, it loses one-fourth of its carbonic acid, and is converted into sesquicarbonate. At a low red heat the salt loses half its carbonic acid and the whole of its water, and is converted into pure carbonate. 50 grains thus treated leave 34½ of carbonate, which requires for exact saturation 500 gr. measures of the volumetric solution of oxalic acid. The aqueous solution has no action on turmeric paper. It effervesces abundantly (CO_2) with hydrochloric acid; and the saturated solution gives, with perchloride of platinum, the usual reactions of a salt of potash. It is distinguished from carbonate by a solution of corrosive sublimate, which gives a brick-red precipitate with the latter, and only a slight white precipitate or opalescence with the former. This test, however, fails with the carbonate if chloride of sodium be present. The bicarbonate causes no precipitate with a solution of sulphate of magnesia until the mixture is boiled; but this does not prove the absence of carbonate, which may be largely mixed with the bicarbonate without inducing a precipitate of carbonate of magnesia. 20 grains of bicarbonate of potash neutralise 14 of citric and 15 of tartaric acid.

Incompatibilities.—Those of carbonate of potash. Lime water, chloride of calcium, alkaline, earthy and metallic salts.

Action and Uses.—Unlike caustic potash and the carbonate, this salt has no local caustic or irritant action, and being neutral, it is the most eligible of the three for internal use. Its constitutional effects are the same. It is a valuable remedy in acute rheumatism; it should be given in large doses until the urine becomes neutral. Given with the vegetable acids in the proportion above stated, and during effervescence, it is very serviceable in allaying vomiting due to irritation or inflammation of the mucous membrane of the stomach. The free carbonic acid is no doubt the chief means of relief. The citrate or tartrate of potash is decomposed in the blood and the bicarbonate is re-formed, which, passing out by the kidneys, renders the urine alkaline.

Dose.—10 to 60 grains, alone, or with vegetable acid or lemon juice.

1. **Liquor Potassæ Effervescens**, *P.B.* *Effervescing Solution of Potash. Potash Water.*

Preparation.—Dissolve 30 grains of *bicarbonate of potash* in 1 pint of *water*, filter, saturate with carbonic acid at a pressure of seven atmospheres, pass into bottles, and securely close them to prevent escape of the compressed gas.

Characters and Tests.—Strongly effervescent of carbonic acid, when liberated, clear and sparkling, and having an agreeable acidulous taste. Ten fluid ounces, after being boiled for five minutes, require for neutralisation 150 gr. measures of the volumetric solution of oxalic acid. Five fluid ounces evaporated to one-fifth, and 12 grains of tartaric acid added, yield a crystalline precipitate, which, when dried, weighs not less than 12 grs. It should be nearly 15 grs.

Action. Uses.—An agreeable form in which to administer potash. It counteracts nausea, and reduces heat in fevers and inflammations. It may be used as a vehicle for medicines with which the bicarbonate of potash is not incompatible.

Dose.—5 fluid ounces to 1 pint.

2. **Pulveres Effervescentes Potassæ Citratis.** *Effervescent Potash Powders.*

These may be made in—(1) *one paper*, by mixing together in the state of fine dry powder 1½ ounce of bicarbonate of potash, 1 ounce of citric acid, and 1 ounce of sugar; or (2) the acid and potash may be each distributed in 16 separate papers. From 60 to 120 grains of the mixed powder in half a pint of water forms an agreeable, slightly alkaline effervescent draught.

POTASSA SULPHURATA, *P.B.* *Sulphurated Potash. Sulphuret* or *Sulphide of Potassium. Hepar Sulphuris.* F. *Sulfure de Potassium Sulfaté.* G. *Schwefel Kalium.*

This compound was formerly known by the name of *liver of sulphur.* The solubility of sulphur in an alkaline solution was known to Geber; but Albertus Magnus taught the method of procuring sulphide of potassium by fusion.

Preparation.—Mix 10 ounces of *carbonate of potash* in powder, and 5 ounces of *sublimed sulphur* in a warm mortar, and, having introduced them into a Cornish or Hessian crucible, let this be heated, first gradually until effervescence has ceased, and finally to dull redness, so as to produce perfect fusion. Let the liquid contents of the crucible be then poured out on a clean flagstone, and covered quickly with an inverted porcelain basin, so as to exclude the air as completely as possible while solidification is taking place. The solid product thus obtained should, when cold, be broken into fragments, and immediately enclosed in a green-glass bottle, furnished with an air-tight stopper.

When carbonate potash is melted with sulphur, water and carbonic acid are expelled. The oxygen of the potash combines with a portion of the sulphur to form hyposulphurous and sulphuric acids, which combine with the undecomposed potash. The deoxydised potassium meantime unites directly with the greater portion of the sulphur to form sesquisulphide of potassium (K_2S_3), formerly called tersulphide. Sulphurated potash is therefore composed chiefly of sesquisulphide of potassium mixed with sulphate, sulphite, and hyposulphite of potash. By lapse of time it loses colour, becomes harder, and nearly white and odourless, and is almost wholly converted, by absorption of oxygen, into sulphate of potash, a little unoxydised sulphur separating. This change takes place rapidly when the salt is exposed to the air.

Characters and Tests.—In greenish-yellow fragments, liver-brown when recently broken, alkaline, and acrid to the taste, readily forming with water a yellow solution, having the odour of sulphuretted hydrogen, and evolving it freely when mixed with excess of hydrochloric acid, sulphur being at the same time deposited. The acid fluid, when boiled and filtered (to expel H_2S), is precipitated yellow by perchloride of platinum (potassium), and white by chloride of barium (sulphuric acid). About three-fourths of its weight (sesquisulphide of potassium) are dissolved by rectified spirit—the sulphate and carbonate of potash being insoluble in spirit.

Incompatibilities.—Acids, which evolve sulphide of hydrogen and precipitate sulphur; and metallic salts which give their metal to the sulphur and their acid to the potassium.

Action. Uses.—In large doses it is an acrid narcotic poison, causing pain, vomiting, purging, syncope, and coma sometimes preceded by convulsions. In medicinal doses it is a stimulant, increasing the pulse and temperature, and augmenting the secretions of the liver and intestinal canal, and of the kidneys and skin. The local action is irritant, and much sulphide of hydrogen is liberated in the stomach. It is chiefly used in chronic skin diseases, such as acne and lepra, and in these it is much more frequently employed as an external than as an internal remedy. As Unguentum potassæ sulphuratæ, and as a bath (4 ounces to 30 gallons of water), it is an useful remedy in the fungous skin diseases, in scabies, and psoriasis. It has also been recommended in lead poisoning.

Dose.—3 to 10 grains, with honey or with soap, made into pills. Externally as an ointment or solution (1 part to 40 or 60), or in baths (1 part to 1500 of water).

1. **Unguentum Potassæ Sulphuratæ,** *P.B. Ointment of Sulphurated Potash.*

Preparation.—Triturate 30 grains of *sulphurated potash* in a porcelain mortar, and gradually add 10 ounces of *prepared lard*, rubbing them ogether until the ointment is perfectly smooth and free from grittiness.

This ointment, when used, should be recently prepared. Used in scabies and chronic skin diseases (see above).

POTASSÆ SULPHAS, *P.B. Sulphate of Potash.*

$KO,SO_3 = 87$ or $K_2SO_4 = 174$.

Kali Vitriolatum. Sal Polychrestum. F. *Sulfate de Potasse.*
G. *Schwefelsaures Kali.*

Sulphate of potash is anhydrous, and contains in 100 parts 54·02 of K_2O, and 45·98 of SO_3. Its specific gravity is 2·64. It is found near volcanoes, in a few minerals (alum and polhalite), some mineral waters, in many plants, and in some animal secretions. The acid sulphate is formed in large quantities in the preparation of nitric acid from nitrate of potash (see p. 69). The neutral sulphate is readily prepared from this by dissolving it in water, and exactly neutralising with carbonate of potash: $2KHSO_4 + K_2CO_3$

$=2K_2SO_4+H_2O+CO_2$. The carbonic acid escapes with effervescence, and the salt is crystallised from the neutral solution. Chalk is sometimes used to effect the neutralisation, in which case the insoluble sulphate of lime must be carefully separated by subsidence and filtration before the solution is crystallised. The crystals are usually formed with great regularity, and their form is characteristic.

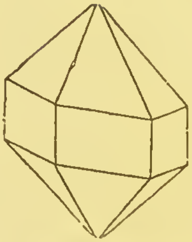
Fig. 27.

Characters and Tests.—In short, hard, colourless, six-sided prisms terminated by six-sided pyramids; taste bitterish and saline; decrepitates strongly when heated: sparingly soluble in water (requires about 16 parts at 60° and 4 at 212°), insoluble in alcohol. The aqueous solution is neutral to test paper (absence of acid sulphate); gives no precipitate with oxalate of ammonia (absence of lime); but acidulated with hydrochloric acid it is precipitated white (sulphuric acid) by chloride of barium, and yellow (potassium) by perchloride of platinum.

This salt is not liable to adulteration, and it undergoes no change on exposure to the air. Heated with charcoal it is converted, like other sulphates, into a sulphide of the base.

Incompatibilities.—Tartaric acid, chlorides of barium and calcium, acetate and diacetate of lead. Nitrate of silver.

Action.—A mild laxative. It is an excellent aperient for children.

Uses.—It is employed in the following preparations: Pilula colocynthidis composita, Pilula colocynthidis et hyoscyami, Pulvis ipecacuanha compositus (4 parts in 5). It is supposed to promote the activity of these preparations by keeping their particles separate, and so allowing the secretions a more speedy and thorough access to them.

Dose.—10 grains to 2 drachms.

HYDROPOTASSIC SULPHATE. *Acid Sulphate of Potash.*

$KO,HO,2SO_3=136$ or $KHSO_4=136$.

Potassæ Supersulphas. Sal Enixum. F. *Bisulphate de Potasse.* G. *Doppelt Schwefelsaures Kali.*

Bisulphate of potash is obtained as a residual salt in the manufacture of nitric acid (see p. 69); or it may be made by adding an excess of sulphuric acid to the sulphate, and evaporating to form crystals.

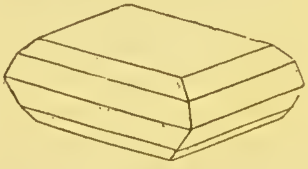
Fig. 28.

Properties.—It is colourless and without odour, but has a very acid bitter taste. It crystallises in small flat prisms belonging to the right rhombic system. It is very soluble in water, but insoluble in alcohol; unalterable in dry air; moderately heated, the crystals melt into an oily-looking fluid; at a red heat lose their water of crystallisation and one proportion of acid, and become simple sulphate of potash. The solution reddens vegetable blues, and effervesces briskly with alkaline carbonates.

Potassæ Sulphas cum Sulphure, *Glaser's Sal Polychrest,* is formed by deflagrating in a red-hot crucible equal parts of sulphur and nitre. It contains sulphate (K_2SO_4) with sulphite (K_2SO_3) of potash. It may be used as a mild purgative, and given with an equal weight or more of bitartrate of potash. It was formerly much used in dyspepsia and chronic cutaneous diseases. Dr Duncan says that in use it agrees with the sulphureous waters.

Dose.—$\frac{1}{2}$ to 1 drachm.

POTASSÆ NITRAS, *P.B.:* $KO,NO_5 = 101$ or $KNO_3 = 101$.

Potassic Nitrate. Nitre. Nitrum. Sal Petræ. Saltpetre. F. *Nitrate de Potasse. Nitre.* G. *Salpeter. Salpetersaures Kali.*

Nitrate of potash, or saltpetre, being a natural production, must have been early known, especially as both the Indians and Chinese have long been acquainted with making gunpowder and fireworks; and the former people have an early process for making nitric acid, in which they have been followed by Geber and other Arabian authors. The names *neter* in the Old Testament, and *nitrum* in ancient authors, were applied to carbonate of soda, but they were also used in a generic sense, signifying several substances.

Production.—Nitre is found effloresced on the soil or disseminated through the superficial layers, in many parts of India, and being washed out, a fresh crop is formed after a few years. The soil which furnishes it is sandy, and consists principally of porous calcic carbonate and decomposing felspar or mica, usually containing more or less decomposing vegetable matter. Mr Stevenson (Prinsep's Journ. ii. p. 23) has shown that the saline earth contains of salts soluble in water, sulphate of soda, chloride of sodium, nitrates of lime and of potash. The nitrate of lime is converted into that of potash by lixiviating the saline soil over a filter of wood-ashes, which contains carbonate of potash, a carbonate of lime is precipitated, and the nitrate potash in solution is evaporated and put aside to crystallise. The salt obtained contains from 45 to 70 per cent. of nitrate of potash. It is redissolved and crystallised, but still contains impurities. The ordinary kinds are called "*rough* or *crude*" saltpetre, and the purer, "*East India refined.*" In Sumatra, nitrous earth is obtained from large caverns, the soil of which consists mainly of the decomposed dung of bats and birds.

It has been shown (p. 69) that oxygen and nitrogen combine directly in porous substances containing an alkaline base to form nitric acid. It seems to be more readily formed by the intervention of ammonia. Thus the French academicians obtained a large quantity of nitrate of potash by hanging a basket of purified chalk saturated with carbonate of potash, over a vessel containing putrefying blood for a few months. Even in temperate climates the surface soil and water invariably contains nitrites, or nitrates, formed by the same process. The quantity being always proportionate to the amount of putrefying organic matter in the soil.

In Europe nitre is prepared artificially in nitre-beds or plantations. Refuse animal and vegetable matters are mixed with ashes and lime rubbish, and thrown into loose heaps or beds, exposed freely to the air, and under sheds. The heaps are kept damp by watering them from time to time with urine or stable runnings, and at intervals of about three years the beds are lixiviated, and the salt is crystallised. A large quantity of nitrates of lime and magnesia are formed, and these are converted into nitrate of potash by the addition of carbonate of potash (in the form of wood-ashes), as long as any precipitate forms. Insoluble carbonates of magnesia and lime fall, thus $K_2CO_3 + Ca2NO_3 = 2KNO_3 + CaCO_3$. A cubic foot of the bed yields between 4 and 5 ounces of nitre.

Properties.—Is anhydrous, of sp. gr. 2·07; it contains in 100 parts 46·54 of K_2O and 53·46 of N_2O_5. It is fusible at 642°·2 without decomposition, and when cast into moulds forms a white opaque crystalline mass of fibrous structure (*sal prunelle* in balls, or *nitrum tabulatum* in thick lozenges). Heated to redness it loses oxygen, and is converted into a deliquescent nitrite. At a greater heat more oxygen is expelled, and a mixture of only potash and potassic peroxyde remains. Crystallises in long striated six-sided prisms, terminated by dihedral summits (fig. 29), or by spontaneous evaporation on a slip of glass in microscopic rhombohedra, isomorphous with nitrate of soda. The large crystals of the commercial salt are translucent from the presence of a little moisture in their interstices, but the pure salt is dry, whitish, and rather opaque. It has a sharp, cooling taste; is soluble in 3½ parts of cold, and about a third of its weight of boiling water; insoluble in alcohol. It parts with oxygen when heated with any oxydisable substance, the latter undergoing oxydation or combustion, and the process is usually attended by *deflagration* (see Potassæ sulphas cum sulphure, p. 134). 3 parts of nitre, and 1 each of sulphur and sawdust, burn with such intense heat that a silver coin may be melted in a quantity sufficient to embed it. Paper soaked in solution of nitre and dried (touch paper) when once kindled, is gradually consumed with scintillation. Thus nitre is one of the most powerful oxydising agents.

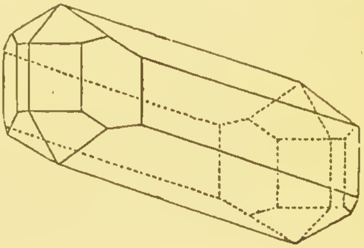

Fig. 29.

Characters and Tests.—In white crystalline masses, or fragments of striated six-sided prisms, colourless, of a peculiar cool saline taste. Thrown on the fire it deflagrates. Warmed in a test tube with sulphuric acid and copper wire, it evolves ruddy fumes (showing the presence of nitric acid (see p. 72). Its solution, acidulated with hydrochloric acid, gives a yellow precipitate with perchloride of platinum (potassium); but is not affected by chloride of barium or nitrate of silver (absence of sulphates and chlorides). The nitrate of potash of commerce being chiefly required for gunpowder is usually almost pure. The Pharmacopæia directs it to be purified, if necessary, by re-crystallisation.

Incompatibility.—Sulphuric acid.

Action. Uses.—In poisonous doses (1 to 1½ oz., retained and only slightly diluted) nitre causes violent gastric and intestinal inflammation, attended by pain, vomiting, and purging, followed by collapse. It is therefore an *irritant.* In medicinal doses it is readily absorbed into the blood, and, according to Dr Stevens, when given freely, it renders the venous blood, even in the last stage of fever, scarlet, and retards or prevents its coagulation. In these effects it resembles carbonic oxyde (see p. 97). Its outward effects are manifested in diaphoresis, diuresis, and diminution of the pulse. Hence nitre may be regarded as a direct *antiphlogistic*, preventing the adhesion of the red corpuscles and keeping the fibrin in solution, while the temperature is lowered by its *diaphoretic* action. As it passes unchanged through the kidneys, its *diuretic* action is no doubt due to direct stimulation of the kidneys. As a local *refrigerant*, nitre is commonly used with sal-ammoniac, 5 oz. of each of these salts mixed with 10 ounces of water reducing the temperature from 50° to 10°. The mixture should be placed in a black India-rubber bag. Nitrate of potash is beneficial in pyrexia, from whatever cause arising, excepting however gastritis, or acute nephritis, where its local irritant action may do harm. It has been largely employed in rheumatic fever, and with good effects. Half an ounce, dissolved in a quart of lemonade or barley water, may be given during the 24 hours. Nitre has been recommended in purpura hæmorrhagica, but, as might be inferred from its influence on the blood, it is useless in every variety of scurvy. As a stimulant to the mucous membrane of the genito-urinary passages, it has been recommended in enuresis and gonorrhœa.

Dose.—10 to 30 grains, with sugar, or in water or mucilaginous drinks.

Antidotes.—A mustard emetic, with copious draughts of water, followed, if need be, by the use of the stomach-pump.

POTASSÆ CHLORAS, *P.B.* $KOClO_5=122{\cdot}5$ or $KClO_3=122{\cdot}5$.

Potassic Chlorate, or *Chlorate of Potassium.* F. *Chlorate de Potasse.* G. *Chlorsaures Kali.*

Chlorate of potash contains in 100 parts 38·36 of K_2O and 61·64 of Cl_2O_5. Though previously known, it was first clearly distinguished from other salts by Berthollet. It is now largely manufactured for the preparation of detonating compounds and lucifer matches.

Preparation.—This salt may be prepared by passing a stream of chlorine through caustic potash to saturation, the chlorine effecting the same changes as iodine under the same circumstances (see p. 80); but since only 1 equiv. of chlorate is produced for every 6 equivs. of chlorine absorbed, the Pharmacopœia has adopted the more economical method whereby the whole of the potash is converted into chlorate. This is effected by passing the chlorine evolved by a gentle, slow heat, from a mixture of 80 ounces of black oxyde of manganese, and 24 pints of hydrochloric acid diluted with 6 pints of water, and previously washed by passing it through 6 ounces of water,—into a mixture of 20 ounces of carbonate of potash, and 53 ounces of slaked lime, made moist with a few ounces of water, and contained within a large carboy. Since the carbonate of potash is immediately converted into caustic potash by the formation of carbonate of lime, and since the caustic lime is present in excess, it follows that the mass upon which the chlorine is directed is composed of a mixture of caustic lime, caustic potash, and carbonate of lime. With the latter of these the chlorine has no action, but it combines with equal avidity with the two former, to form both chlorates and chlorides of the two metals, thus with respect to the lime, $6Cl + 6CaHO = 5CaCl + CaClO_3 + 3H_2O$, and so also with the potash,—the actions of the halogens upon the caustic alkalies and earths being identical. By this action we have, therefore, a mixture of the chlorates of potash and lime, with chlorides of potassium and calcium. But chlorate of lime and chloride of potassium decompose each other, forming chlorate of potash and chloride of calcium, thus: $Ca2ClO_3 + 2KCl = 2CaCl_2 + KClO_3$, and thus the whole of the potash is converted into chlorate.

When the whole of the chlorine has passed over, the contents of the carboy are boiled for 20 minutes with 7 pints of water. The solution is filtered from the carbonate of lime and excess of caustic lime, and evaporated till a film forms on the surface, and then, on cooling, the slightly soluble chlorate of potash crystallises out, and leaves the very soluble chloride of calcium in solution. The crystals are removed, drained, washed with a little cold water, and purified from any adhering chloride of calcium by solution in three times their weight of boiling water, and re-crystallisation.

Characters and Tests.—In colourless, anhydrous, rhomboidal (more or less regular six-sided) plates, striated in lines parallel to the edges, and permanent in the air; a sharp cooling taste like nitre, soluble in 16 parts of cold water, and in rather less than 2 parts at 212° (61·5 of the salt in 100 of water). Heated to between 700° and 800° it melts, and at a higher temperature parts with its oxygen, and is reduced to chloride of potassium. 100 parts heated to redness yields 38·36 of pure oxygen and 61·64 parts of potassic chloride,—a white residue, which is precipitated white ($AgCl$) by nitrate of silver, and yellow ($2KCl,PtCl_4$) by perchloride of platinum (thus indicating KCl). Aqueous solution of the chlorate is not affected by nitrate of silver (absence of chloride), or oxalate of ammonia (absence of lime). The chlorate explodes when triturated with sulphur. This is due to its oxydising properties, which are even greater than those of nitre.

CHLORATES.—Chlorate of potash may be taken as the type of these. They scintillate when thrown upon ignited charcoal, and when heated with combustible bodies, such as sulphur or phosphorus, they explode violently. In contact with sulphuric acid, peroxyde of chlorine (ClO_2), a dangerously explosive gas is formed. An explosive gas (*euchlorine*) is also formed when the salt is gently heated with hydrochloric acid; but in the cold, and in the presence of water, chlorine is evolved. Paper soaked in a solution of chlorate and dried burns as touch paper. A chlorate in solution is distinguished from a nitrate by adding a few drops of solution of indigo in sulphuric acid (which liberates chloric acid), and then solution of sulphurous acid (which reduces the chloric acid to chlorine) when the blue colour disappears. Potassic chlorate is employed for converting the metallic protoxides into peroxydes (see p. 144, &c).

Action. Uses.—A hasty assumption that chlorate of potash parted with 38 per cent. of its weight of oxygen in passing through the body led to the use of this salt in conditions of the system associated with or dependent upon defective oxydation. Chlorate of potash, however, undergoes no such change, and is eliminated by the kidneys unchanged. It does not even possess diuretic properties, and may be fairly regarded as having no appreciable action after it is admitted into the blood. In the solid form it is slightly stimulant to congested mucous membrane; and it is useful as furnishing a means for the extemporaneous preparation of a solution of chlorine. (See "Mistura chlorinii acida," below).

Dose.—10 to 30 grains. It may be given in lozenges, as follows:—

1. Trochisci Potassæ Chloratis, *P.B. Chlorate of Potash Lozenges.*

Preparation.—Mix 3600 grains of *chlorate of potash*, 25 ounces of *refined sugar*, and 1 ounce of *gum acacia*, all in powder, together; add 2 fluid ounces of *mucilage of gum acacia*, and an ounce of *water* or a sufficiency, to form a proper mass. Divide into 720 lozenges, and dry these in a hot-air chamber with a moderate heat.

Each lozenge contains 5 grains of the chlorate.

Dose.—1 to 6 lozenges. A stimulant in relaxed throat.

2. Mistura Chlorinii Acida.

A useful solution for internal use, or as a gargle, may be thus formed. Pour 2 fluid drachms of hydrochloric acid on 20 grains of powdered chlorate of potash, and when the solution is effected, add enough water to make the mixture measure 10 fluid ounces. *Euchlorine*, an explosive yellow gas, composed of a mixture of chlorine and chlorochloric acid ($2Cl_2O_5Cl_2O_3$) is slowly formed and dissolved in the water.

Dose.—$\frac{1}{2}$ to 1 fluid ounce.

IODATE OF POTASH, *P.B.*: KO,IO_5 or KIO_3. *Solution of.*

Preparation.—50 grains each of *iodine* and *chlorate of potash*, are rubbed together to a fine powder and placed in a Florence flask. Half an ounce of *water* acidulated with 8 minims of nitric acid is poured upon it, and the mixture is digested at a gentle heat until the colour of the iodine disappears. It is boiled for a minute, then transferred to a capsule and evaporated to dryness at 212°. The residue is dissolved in 10 ounces of water, and the solution filtered and kept in a stoppered bottle.

In this process the iodine simply displaces the chlorine of the chlorate: $2KClO_3 + I_2 = 2KIO_3 + Cl_2$. The nitric acid merely facilitates the transfer, and both it and the chlorine are expelled by the boiling.

This is used as a test for sulphurous acid, which, by abstracting oxygen, reduces it to iodine, a portion of the sulphuric acid formed uniting with the potash, thus: $2KIO_3 + 6H_2SO_3 = K_2SO_4 + 6H_2SO_4 + I_2$.

POTASSÆ TARTRAS, *P.B.* *Tartrate of Potash.*

$2KO,C_8H_4O_{10} = 226$ or $K_2C_4H_4O_6 = 226$.

Neutral or *Bibasic Tartrate.* *Dipotassic Tartrate.* F. *Tartrate de Potasse.* G. *Einfach Weinsaures Kali.*

Tartrate of potash has not been found in nature, but has been known to chemists since the time of Lemery, in the seventeenth century.

Preparation.—Dissolve 9 ounces of *carbonate of potash* in 2½ pints of water, add 20 ounces of *acid tartrate of potash*. Boil for a few minutes, and if the liquid be not neutral to test paper make it so by the addition of more of the carbonate, or of the acid tartrate. Then filter, concentrate till a pellicle forms, and set aside to crystallise. Evaporate the mother-liquor and get more crystals. Drain, and dry them in a current of warm air, and preserve in a stoppered bottle.

In this decomposition the hydrogen of the acid tartrate is displaced by potassium, carbonic acid, and water being at the same time liberated, thus: $2KHC_4H_4O_6 + K_2CO_3 = 2K_2C_4H_4O_6 + CO_2 + H_2O$.

Characters and Tests.—In small, colourless, four or six-sided (right rhombic) prisms, neutral, permanent in the air. Taste mild, saline, and bitterish. Entirely soluble in its own weight of water. Acetic acid added sparingly to its solution causes the separation of a white crystalline precipitate (of acid tartrate). Heated with sulphuric acid it forms a black tarry fluid, evolving inflammable gas and the odour of burnt sugar. When strongly heated it soon chars, and evolves the odour of caramel, and much combustible gas; a black deliquescent mass remains, composed of a mixture of charcoal and carbonate of potash. 113 grains heated to redness till gases cease to be evolved, leave an alkaline residue, which requires for exact neutralisation 1000 gr. measures of the volumetric solution of oxalic acid.

Tartrate of potash is liable to admixture with small quantities of carbonate or bitartrate of potash; the former renders it slightly deliquescent, the latter confers an acid reaction. If sulphuric acid be present, chloride of barium will give a white precipitate insoluble in nitric acid.

Incompatibilities.—Acids (even acetic) and acidulous salts precipitate the acid tartrate. Soluble salts of lime (notably CaCl which does not precipitate the acid tartrate), of magnesia, baryta, lead, and silver, give precipitates of tartrates, which are hardly or not at all soluble in water, but soluble in nitric acid.

Action. Uses.—In doses of ½ to 1 drachm diuretic, rendering the urine alkaline; in doses of 2 to 8 drachms, aperient. After the action of a brisk purge, it is an appropriate medicine in gout, rheumatism, or hepatic congestion, to promote the action of the kidneys and liver, and to carry out uric acid. It is eliminated by the kidneys as carbonate of potash.

Dose.—60 grains to ½ an ounce.

POTASSÆ TARTRAS ACIDA, *P.B. Cream of Tartar.*

$KO,HO,C_8H_4O_{10}=188$ or $KHC_4H_4O_6=188$.

Acid Tartrate of Potash. Bitartrate of Potash. Argol. F. *Tartrate Acide de Potasse.* G. *Doppelt Weinsaures Kali.*

An acid salt obtained from the crude tartar which is deposited during the fermentation of grape juice. In the fermentation of wine, sugar disappears and alcohol is formed, and the salt not being soluble in this, is deposited on the bottom and sides of casks, as a crystalline crust, which, according to the colour of the wine, forms either *red* or *white tartar*, or *argol.* This was known to the ancients, and is the Fæx Vini of Diosc. v. c. 13. (Hindoo Med. p. 97.) Its nature was determined by Scheele in 1769. It is composed of the acid tartrate of potash, tartrate of lime, and colouring matter. The two last mentioned impurities are removed by solution in water and the use of clay and charcoal. It is largely purified both at Montpellier and Venice.

Characters and Tests.—A gritty white powder, composed of minute hard prisms, or fragments of cakes crystallised on one surface; of a pleasant acid taste, sparingly soluble in cold water (requiring 180 parts); boiling water dissolves about ⅙ of its weight, and on cooling, deposits the salt in pure white, opaque, oblique rhombic prisms (fig. 30); insoluble in spirit. Heated in a crucible, it behaves like the tartrate (see p. 139), but the residue (*black flux*) is less bulky; this effervesces (CO_2) with dilute hydrochloric acid, and the clear solution, when separated from the charcoal, gives a yellow precipitate ($2KCl,PtCl_4$) with perchloride of platinum (indicating potash); and when neutralised by ammonia, is rendered slightly turbid by oxalic acid (indicating a trace of lime). 188 grains heated to redness till gas ceases to be evolved, leave an alkaline residue, which requires for exact neutralisation 1000 gr. measures of the volumetric solution of oxalic acid. With salifiable

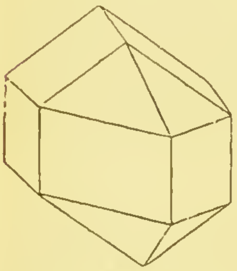

Fig. 30.

bases forming soluble tartrates, acid tartrate of potash, forms double salts, several of which are officinal, as tartarated soda, tartarated antimony, and tartarated iron. Boracic acid and borax much increase the solubility of cream of tartar. (See Boro-tartrate of Potash or Soluble Cream of Tartar.)

Impurities and Adulterations.—The quantity of *tartrate of lime* should not exceed 2 per cent.; from 5 to 14 per cent. have been found in it. *Sulphate of potash* and *alum* have been used as adulterations. The sulphuric acid is detected by chloride of barium (tartrate of baryta is soluble in nitric acid, sulphate is not). The alumina is detected in the residue of the black flux from which the carbonate has been thoroughly washed, by boiling it in water, filtering the solution, and testing with sulphide of ammonium. If alumina be present, a white precipitate is formed.

Incompatibilities.—Alkaline carbonates are decomposed with evolution of CO_2 and the formation of neutral tartrate (see preparation of Potassæ tartras and Sodæ tartarata). Soluble salts of magnesia, baryta, and lead are precipitated, sparingly soluble tartrates being formed. Lime at first gives a precipitate, but this is dissolved in excess of the acid tartrate. Soluble salts of lime give no precipitate. The mineral acids slowly decompose the acid tartrate.

Action and Uses.—Refrigerant, diuretic, laxative. In large doses (3 to 4 ounces) it causes violent gastro-intestinal inflammation. When there is intestinal torpor it is useful as a stimulant purge, but it is apt to cause griping. As an aperient, it is usually combined with sulphur or jalap. It is eliminated as carbonate of potash by the kidneys; but it is not so appropriate a remedy in uric lithiasis as the neutral tartrate. A saturated aqueous solution, flavoured with lemon or orange peel, is a pleasant drink in pyrexial conditions.

Dose.—$\frac{1}{2}$ to 2 drachms as a diuretic; 4 to 6 drachms as a laxative.

Pharmaceutical Uses.—In the preparation of Pulvis jalapæ compositus and Confectio sulphuris, Acidum tartaricum, Antimonium tartaratum, Ferrum tartaratum, Sodæ tartarata, and Potassæ tartras.

POTASSÆ BORO-TARTRAS, *Soluble Tartar:* $K,BO,C_4H_4O_6$.

In this salt a molecule of boracic acid takes the place of an atom of potassium in the cream of tartar. It is prepared by boiling together 1 part of boracic acid and 2 parts of cream of tartar in 24 parts of water, and evaporating the solution to dryness and washing with alcohol to remove the excess of boracic acid. It is a white amorphous powder, very soluble in water and insoluble in alcohol.

A preparation sufficiently exact for medicinal use may be formed by boiling together 1 part of boracic acid and 4 parts of cream of tartar in 24 parts of water, and evaporating to dryness. It is a white deliquescent powder of sour taste. It is soluble in water in all proportions. A mixture of 1 part of borax and 3 parts of the acid tartrate of potash is soluble in its own weight of water.

Action and Uses.—It possesses the properties of both borax and cream of tartar, being diuretic, purgative, and emmenagogue. Its action is milder than that of cream of tartar.

Dose.—1 drachm as a diuretic; from 6 to 8 drachms as a purgative.

POTASSÆ CITRAS, *P.B.* *Citrate of Potash.*

$3KO,C_{12}H_5O_{11} = 306$ or $K_3C_6H_5O_7 = 306$.

Preparation.—Dissolve 6 ounces of crystals of *citric acid* in 2 pints of *water*, add 8 ounces, or a sufficiency, of *carbonate of potash* gradually; and if the solution be not neutral, make it so by the cautious addition of the acid or the carbonate of potash. Then filter, and evaporate to dryness, stirring constantly after a pellicle has begun to form, till the salt granulates. Triturate in a dry warm mortar, and preserve the powder in stoppered bottles. The carbonic acid escapes with effervescence, and the citric acid, which is tribasic, combines with 3 molecules of potash to form the neutral citrate.

Characters and Tests.—A white powder of saline, feebly acid taste, deliquescent, and very soluble in water. Heated with sulphuric acid, it forms a brown fluid, gives off an inflammable gas (CH_4), and evolves the odour of acetic acid. Its solution, mixed with one of chloride of calcium, remains clear till it is boiled, when a white precipitate (citrate of lime), readily soluble in acetic acid, separates (proving the absence of tartrate, with which $CaCl_2$ gives an immediate precipitate in the cold). Its solution acidulated with hydrochloric acid gives a yellow precipitate ($2KCl,PtCl_4$) with perchloride of platinum. 102 grains heated to redness till gases cease to be evolved, leave an alkaline residue (carbonate of potash mixed with carbon—see tartrate of potash), which requires for exact neutralisation 1000 gr. measures of the volumetric solution of oxalic acid.

The presence of tartrate of potash is readily indicated by a solution of citric acid, which would produce a deposit of crystalline acid tartrate. (For other properties of the citrates, see Citric Acid). When prepared from the commercial carbonate of potash, it is apt to contain the soluble impurities of that salt.

Action, Uses, and Doses.—An excellent mild refrigerant, diaphoretic, and diuretic, in doses of 20 to 40 grains. In large doses, ¼ to 1 ounce, purgative. It may be employed with lemon juice to form a cooling drink in fevers. Like all the other combinations of vegetable acids with the alkalies, it is eliminated as carbonate, rendering the urine alkaline. It may therefore be given as an antilithic in acidity and in gout.

POTASSÆ ACETAS, *P.B.* *Acetate of Potash.*

$KO,C_4H_3O_3=98$ or $KC_2H_3O_2=98$.

Potassic Acetate. Kali Acetatum. Sal Diureticus. Terra foliata Tartari. Digestive Salt of Sylvius. F. *Acetate de Potasse.* G. *Essigsaures Kali.*

Acetate of potash was known (to Raymond Lully) in the thirteenth century, and probably earlier. It is found in the sap of many plants.

Preparation.—Add gradually *carbonate of potash* to *acetic acid* to neutralisation. (2 pints of acetic acid will require about 30 ounces of carbonate). Filter, acidulate with a few drops of acetic acid, and having evaporated to dryness, raise the heat cautiously, so as to liquefy the product. Allow the porcelain basin to cool, and when the salt has solidified and while it is still warm, break it into fragments, and put it into stoppered bottles.

In this process, as in the preparation of the citrate and tartrate, the stronger acid simply displaces the weaker. An acid reaction is given to the solution, to secure the complete neutralisation of the potash, the presence of a very little carbonate producing, during the liquefaction of the salt, a brown discoloration.

Characters and Tests.—Anhydrous, white, foliated, woolly, asbestos-like masses, so deliquescent as to become converted into an oily-looking liquid on exposure to a damp air; a faint acetous odour and sharp, warm, saline taste; soluble in its own weight of water; with an aqueous solution tartaric acid causes a crystalline precipitate (of acid tartrate of potash); sulphuric acid the disengagement of acetic acid; and a dilute solution of iron strikes a deep red colour. Neutral to test paper; entirely soluble in rectified spirit (absence of carbonate and other salts of potash). Its solution is unaffected by sulphide of ammonium (absence of alumina and metallic impurities). When strongly heated, acetate of potash fuses and is decomposed, evolving hydrogen and carbonic acid, the residue being carbonate of potash simply, and not black flux (carbonate of potash and carbon), the residue of the citrate and tartrates.

Incompatibilities.—Acids (which liberate acetic acid). Sulphates of soda and magnesia, and the earthy and metallic salts generally.

Action. Uses—Diuretic: in large doses, purgative. If continued it will render the urine alkaline, as carbonate of potash does; for, like other salts of the alkalies with vegetable acids, it is apt to be converted into a bicarbonate while in the system. (Wöhler). It is therefore an appropriate remedy in gout, rheumatism, and in uric lithiasis.

Dose.—10 to 60 grains as a diuretic; 1 to 3 drachms as a purgative.

Pharmaceutical Uses.—In the preparation of Tinctura ferri acetatis and the following:—

1. **Solution of Acetate of Potash.**—Composed of ½ ounce of the salt dissolved in 5 fluid ounces of water. It is used as a test for tartaric acid, with which it gives a colourless crystalline precipitate of acid tartrate of potash.

POTASSÆ PERMANGANAS, *P.B.* *Permangante of Potash.*

$KO,Mn_2O_7 = 158$ or $KMnO_4 = 158$.

This is a combination with the most highly oxydised form of manganese, permanganic acid ($HO,Mn_2O_7 = 120$ or $H_2Mn_2O_8 = 240$).

Preparation.—Mix together 3½ ounces of *chlorate of potash* and 4 ounces of *black oxyde of manganese*, both in fine powder; put the mixture into a porcelain basin, and add to it 5 ounces of *caustic potash*, previously dissolved in 4 ounces of *water.* Evaporate to dryness on a sand bath, stirring diligently to prevent spurting. Pulverise the mass, put it into a covered Hessian or Cornish crucible, and expose it to a dull red heat for an hour, or till it has assumed the condition of a semifused mass. Let it cool, pulverise it, and boil with 1½ pint of *water.* Let the insoluble matter subside, decant the fluid, boil again with ½ pint of *water;* again decant, neutralise the united liquors accurately with *dilute sulphuric acid*, and evaporate till a pellicle forms. Set aside to cool and crystallise. Drain the crystalline mass, boil it in 6 ounces of *water*, and strain through a funnel the throat of which is lightly obstructed by a little asbestos. Let the fluid cool and crystallise, drain the crystals, and dry them by placing them under a bell jar over a vessel containing sulphuric acid.

When black oxyde of manganese (MnO_2) and chlorate of potash are heated together, the latter yields up its oxygen (see chlorates, p. 138) to the former, and converts it into manganic acid (H_2MnO_4), which unites with the potash: $2HKO + H_2MnO_4 = K_2MnO_4 + 2H_2O$. The dark green mass resulting from fusion, contains a mixture of manganate and chloride of potassium. The manganates are very unstable; their solutions are decomposed by boiling, with a change of colour, from green to red, into permanganate of the base and peroxyde of manganese. This decomposition occurs in the second stage of the process, and the solution is decanted from the insoluble black oxyde; the liberated potash is neutralised by sulphuric acid, and when the permanganate is crystallised out the remaining liquor contains sulphate of potash and chloride of potassium.

Characters and Tests.—Dark purple, slender prismatic crystals, inodorous, with a sweet astringent taste, soluble in 16 parts of water at 60°. A single small crystal suffices to form, with an ounce of water, a rich purple solution, which when mixed with a little rectified spirit and heated becomes yellowish brown (from reduction of the permanganic acid to hydrated peroxyde, the alcohol being oxydised to acetic acid, which combines with the liberated base to form acetate of potash). The crystals heated to redness decrepitate, evolve oxygen, and leave a black residue from which water extracts potash (being reduced to a mixture of the black oxyde and caustic potash) recognised by its alkaline reaction and the platinum test (p. 122). Entirely soluble in cold water. Five grains dissolved in water require for complete decoloration a solution of 45 grains of granulated sulphate of iron acidulated with 2 fluid drachms of dilute sulphuric acid (persulphate of iron is formed, and black oxyde of manganese falls).

Action and Uses.—The readiness with which it yields up its oxygen characterises this salt. A protosalt of iron, or an organic compound, decomposes it at once. A sufficient quantity of a deoxidiser removes 3 atoms of oxygen from the solution of permanganate. The solution of permanganate, like other oxydisers, decomposes sulphuretted hydrogen, removes bad smells, and thus acts as a disinfectant. Ochre-coloured hydrated per- or black oxyde of manganese, is simultaneously precipitated, and the purple solution becomes colourless.

It is not much used internally as it is immediately decomposed by the animal fluids.

1. Liquor Potassæ Permanganatis, *P.B.* *Solution of Permanganate of Potash.*

Contains 4 grains of the salt in each ounce of water.

This solution resembles "*Condy's disinfecting fluid,*" and is an admirable deodoriser for the sick-room. It may be further diluted to form a wash or injection for cancerous or foul ulcers, a gargle for fœtid breath or putrid sore throat. It has been given internally in diabetes and other disorders.

Dose.—2 to 4 drachms.

POTASSÆ BICHROMAS, *P.B.* $KO,2CrO_3 = 147{\cdot}5$ or $K_2Cr_2O_7 = 295$.

Bichromate of potash, or potassic dichromate, contains in 100 parts K_2O, 31·93; CrO_3, 68·07. It is prepared by roasting chrome iron stone (FeO,Cr_2O_3) with carbonate and nitrate of potash, and dissolving the salt from the peroxyde of iron.

Characters and Tests.—In large red transparent four-sided tables, anhydrous; fuses below redness; at a higher temperature is decomposed, yielding green oxyde of chromium and yellow chromate of potash, which may be separated by dissolving the latter in water. The bichromate dissolved in water gives a yellowish-white precipitate ($BaCrO_4$), and a purplish red precipitate (Ag_2CrO_4) with nitrate of silver, and both of these precipitates are soluble in dilute nitric acid (proving the absence of sulphates and chlorides). The solution also, when digested with sulphuric acid and rectified spirit, acquires an emerald green colour (chromic sulphate, Cr_23SO_4, the liberated oxygen converting the alcohol into aldehyd).

Pharmaceutical Uses.—As a powerful oxydising agent in the preparation of Sodæ valerianas, and in determining the quantity of protoxide of iron is solution.

1. VOLUMETRIC SOLUTION OF BICHROMATE OF POTASH, 1000 gr. meas. = 14·75 grains.

Preparation.—Put 147·5 grains of the bichromate into a 10,000 grain flask with water, and when the salt is dissolved, add water to make the exact bulk of 10,000 gr. measures. 1000 gr. measures contain 14·75 grains of the bichromate ($=\frac{1}{10}$ of an equivalent of

$KO,2CrO_3$, or $\frac{1}{20}$ of an equiv. of $\mathbf{K_2Cr_2O_7}$ in grains), and when added to a solution of a protosalt of iron acidulated with hydrochloric acid are capable of converting 16·8 grains of iron ($=\frac{1}{10}$ of 6Fe or $\frac{1}{20}$ of **6Fe** in grains) from the state of protosalt to that of persalt.

If the metrical system be used, 14·75 grammes of the bichromate should make 1000 cubic centimeters of solution. 100 cubic centimeters of this contain 1·475 grammes of bichromate ($=\frac{1}{100}$ of $KO2CrO_3$ or $\frac{1}{200}$ of $\mathbf{K_2Cr_2O_7}$ in grammes), and are capable of converting 1·68 grammes of iron ($=\frac{1}{100}$ of 6Fe or $\frac{1}{200}$ of **6Fe** in grammes) from the state of protosalt to that of persalt.

Use.—To determine the proportion of protoxyde of iron in the following preparations:—

	Grains.		Gr. meas.		Grammes.		Cub. centim.
Ferri arsenias.	20	=	170	or	2	=	17·0
,, carbonas. sacch.	20	=	330	or	2	=	33·0
,, oxydum magnet.	20	=	83	or	2	=	8·3
,, phosphas,	20	=	250	or	2	=	25·0

It is known that the whole of the protosalt has been converted into a persalt, when a minute drop of the liquid, placed in contact with a drop of the solution of red prussiate of potash on a white plate, ceases to strike a blue colour.

SODIUM or NATRIUM: Na=23 or **Na**=23.

Sodium, the metallic base of soda, was discovered by Davy in 1837. It exists in sea water, rock salt, and in animal and vegetable juices in combination with chlorine. Sodium is of the consistence of wax, malleable, and may be spread into thin leaves. Sp. gr. 0·972. Opaque, but with a brilliant silvery lustre; floats on water, producing a hissing effervescence, in consequence of the escape of hydrogen, while the oxygen of the water combining with the sodium (sometimes with explosive violence) forms a protoxyde (soda), which remains in solution. Sodium fuses at 190°, volatilises at a white heat, and burns with a brilliant flame. It conducts both heat and electricity. As it oxydises in the air, it must be preserved under naphtha. The compounds of sodium give a yellow colour to flame, and are recognised by a bright line across the yellow portion of the spectrum, while those of potassium give a purple tinge to flame, and show a bright line at the limit of the red, and another at the opposite limit of the violet; and those of lithium give a red tinge to flame, and show a brilliant crimson in the red and a paler line across the yellow portion of the spectrum.

Characters of the Salts of Sodium.—These have reference mainly to their distinction from salts of ammonium and potassium. As the absence of any precipitate on the addition of sulphide of ammonium and carbonate of ammonia distinguish the salts of the alkaline metals from all others, the salts of sodium and lithum are distinguished by their solubility. Only one precipitatant—

acid-metantimoniate of potassium—is known for those of soda; and as this causes no precipitate with the salts of the other alkaline metals, it is a decisive test. 1 part of sodium in 10,000 of water gives a crystalline precipitate (antimoniate of soda), with this test after twenty-four hours. But even this test is not available if any other besides the alkaline bases are in the solution. Neither tartaric acid nor perchloride of platinum give any precipitate with solutions of the sodium salts, whereby they are distinguished from those of potassium (see p. 122), as well as from those of ammonium (see p. 121). Salts of soda (excepting common salt) are *efflorescent* in the air; those of potash which are effected by exposure are *deliquescent*. The only *positive tests* therefore of the presence of a salt of sodium is—(1), that it gives a rich yellow tinge to a colourless flame; and (2), when in solution it yields a precipitate by a solution of acid-metantimoniate of potassium.

SODA CAUSTICA, *P.B.* *Caustic Soda.* *Hydrate of Soda.*

$NaO,HO = 40$ or $NaHO = 40$, with some impurities.

Preparation.—This substance is prepared in exactly the same way as caustic potash (see p. 122), using carbonate of soda for that of potash.

Characters and Tests.—Hard and greyish white, very alkaline and corrosive. It imparts a yellow colour to flame, and its solution in water acidulated by nitric acid gives only scanty white precipitates with nitrate of silver and chloride of barium (small quantities of chloride and sulphate). 40 grains dissolved in water leave scarcely any sediment, and require for neutralisation about 900 gr. measures of the volumetric solution of oxalic acid.

The pure hydrate has a sp. gr. of 2·13, and contains in 100 parts Na_2O, 77·5; and H_2O 22·5.

Action. Uses.—Similar to those of caustic potash. It is less caustic and less deliquescent. It is extensively employed in the manufacture of hard soaps.

1. **Liquor Sodæ**, *P.B.* *Solution of Soda.*

Contains 4·1 per cent. by weight of caustic soda.

Preparation.—Dissolve 28 ounces of *carbonate of soda* in 1 gallon of *water*, boil in a clean iron vessel, gradually mix with it 12 ounces of *slacked lime*, and continue the ebullition for ten minutes with constant stirring. Then remove the vessel from the fire; and when, by the subsidence of the insoluble matter, the supernatant liquor has become perfectly clear, transfer it by means of a siphon to a green-glass bottle furnished with an air-tight stopper, and add distilled water if necessary to make it of the required density and neutralising power.

The reaction is identical with that which occurs in the preparation of Liquor potassæ: $Na_2CO_3 + Ca2HO = CaCO_3 + 2NaHO$.

Tests.—Sp. gr. 1·047. 458 grains (=1 fluid ounce) require for neutralisation 470 gr. measures of the volumetric solution of oxalic acid, corresponding to 4·1 per cent. by weight of hydrate of soda, NaO,HO or **NaHO**. It does not effervesce when added to an excess of dilute hydrochloric acid (absence of carbonate). Mixed with an equal volume of water, it gives no precipitate with solution of lime or oxalate of ammonia (absence of carbonate and of lime). When mixed with an excess of dilute nitric acid, and evaporated to dryness, the residue forms with water a clear solution (if silica and alumina be present they form an insoluble residue), which is only slightly precipitated by chloride of barium or by nitrate of silver (traces of sulphate and chloride), and not at all by ammonia (absence of alumina). 1 fluid ounce contains 18·8 grains of hydrate of soda.

In the process for the manufacture of carbonate soda from common salt, a solution of impure caustic soda generally remains after the separation of the carbonate. It contains iron, and is called *red liquor*. Caustic soda is prepared from it by manufacturers on the large scale.

The following table by Dalton shows the proportion of anhydrous soda in solutions of the hydrate of different densities:—

Sp. gr.	NaO_2 in 100 parts.	Sp. gr.	Na_2O in 100 parts.
1·56	41·2	1·32	23·0
1·50	36·8	1·29	19·0
1·47	34·0	1·23	16·0
1·44	31·0	1·18	13·0
1·40	29·0	1·12	9·0
1·36	26·0	1·06	4·7

This solution differs from Liquor potassæ in giving a precipitate with antimoniate of potash, and none with tartaric acid, fluosilicic acid, or perchloride of platinum. Its chemical and therapeutical applications are similar to those of potash, than which it is a weaker base, and a less active remedy.

Uses.—Chiefly Pharmaceutical. The Pharmacopœia employs it in the preparation of caustic soda, sulphurated antimony, and valerianate of soda. It is also employed to ascertain the strength of the several acids in the form of the following solution.

2. Volumetric Solution of Soda.—1000 gr. measures = 40 grains NaOHO or **NaHO**.

Preparation.—Fill a burette with the *Liquor sodæ*, and cautiously drop this into 63 grains of purified *oxalic acid* dissolved in about 2 ounces of *water* until the acid is exactly neutralised, as indicated by litmus. Note the number of gr. measures (n) used, and then, having introduced 9000 gr. measures of the solution of soda into a graduated jar, augment this by the addition of water until it becomes $\frac{9000 \times 1000}{n}$ gr. measures. If, for example, $n = 930$, the 9000 gr. measures should be augmented to . . . . . $\frac{9000\times1000}{930}=9677$ gr. measures. 1000 gr. measures of this solution contain 1 equiv. in grains of hydrate soda = 40 grains, and will therefore neutralise 1 equiv. in grains of any monobasic acid.

Grammes and cubic centimetres may be used instead of grains and grain measures, but for convenience $\frac{1}{10}$th of the numbers should be be taken. 100 cubic centimetres contain $\frac{1}{10}$th of an equivalent in grammes (4 grammes) of hydrate of soda, and will neutralise $\frac{1}{10}$th of an equivalent in grammes of an acid.

This solution is used for testing the following acids:—

	Grains.		Gr. meas.		Grammes.		Cub. centim.
Acetum, . . .	445.4	require	402	or	44·54	require	40·2
Acid. aceticum, .	182·0	„	1000	„	18·20	„	100·0
„ „ dilutum,	440·0	„	313	„	44·00	„	31·3
„ „ glac. .	60·0	„	990	„	6·00	„	99·0
„ citricum, .	70·0	„	1000	„	7·00	„	100·0
„ hydrochloric, .	114·8	„	1000	„	11·48	„	100·0
„ hydrochloric dil.	345·0	„	1000	„	34·50	„	100·0
„ nitricum, .	90·0	„	1000	„	9·00	„	100·0
„ nitricum dilut.	361·3	„	1000	„	36·13	„	100·0
„ nitro-hydroch. dil.	352·4	„	920	„	35·24	„	92·0
„ sulphuricum, .	50·6	„	1000	„	5·06	„	100·0
„ sulphuric arom.	304·2	„	830	„	30·42	„	83·0
„ sulphuric dilutum,	359·0	„	1000	„	35·90	„	100·0
„ tartaricum, .	75·0	„	1000	„	7·50	„	100·0

The point of saturation is indicated by litmus paper.

SODÆ CARBONAS.

$NaO,CO_2+10HO=53+90$ or $Na_2CO_310H_2O=106+180$.

Carbonate of Soda. Disodic Carbonate. Natron præparatum.
F. *Carbonate de Soude.* G. *Kohlensaures Natron.*

Contains in 100 parts Na_2O 21·68, CO_2 15·39, and H_2O 62·93.

Carbonate of soda is the *neter* of the Hebrews. It was known to the early Hindoos, and is by them called *Sajji noon* (*i.e.*, *Sajji*, or Soda salt); it is the *Sagimen vitri* of Geber. The natron lakes of Egypt were known to the ancients, and it was early employed in glass-making, &c. In the impure form it is known in this country as washing soda.

The following are the sources of carbonate of soda:—

1. **Native Carbonate of Soda** (*Natron, Trona*) is obtained as an efflorescence from the borders of large lakes near Tripoli, to the west of the Nile delta, and of the Lonar lake in the Deccan. It is a sesquicarbonate of soda.

2. **Barilla** is the ash obtained by burning plants, on the shores of the Mediterranean, of the Red Sea, and Indian Ocean. These plants belong mostly to the natural family Chenopodiaceæ, and chiefly to the genera Salsola, Salicornia, Sueda, and Chenopodium. The quantity of carbonate of soda in the ash varies from 25 to 40 per cent. It is produced by the combustion of soda salts of the vegetable acids.

3. **Kelp** (see p. 75) contains from 3 to 8·5 per cent. of carbonate of soda.

4. Carbonate of soda is, however, now obtained very cheaply from chloride of sodium or sea-salt. This is first converted into sulphate of soda by the action of sulphuric acid (see p. 91), then mixed with pounded small coal and chalk, and heated in a reverberatory furnace and stirred. The carbonaceous matter abstracts oxygen both from the sulphuric acid and the soda; sulphide of sodium is formed and carbonic oxyde liberated: $Na_2SO_4 + 2C_2 = Na_2S + 4CO$. The sulphide of sodium and carbonate of lime now react upon each other, and produce carbonate of soda and sulphide of calcium, $Na_2S + CaCO_3 = Na_2CO_3 + CaS$. An excess of chalk is, however, employed in order to prevent, in the subsequent process of lixiviation, the decomposition of the carbonate of soda by sulphide of calcium, and to form, instead of the latter, an insoluble oxysulphide of calcium, from which the carbonate of soda may be washed. The crude mass is lixiviated with warm water, the solution evaporated, and the carbonate of soda crystallised out.

Characters and Tests.—Carbonate of soda, prepared as above, and purified by recrystallisation, is usually very pure, but the salt is apt to contain some sulphate of soda, and also the chlorides of sodium and of potassium. It is in large, transparent, colourless laminar (?) crystals of a rhombic shape (oblique rhombic prisms, or rhomboidal octohedrons) entire or broken. Efflorescent, but with a harsh alkaline taste and strong alkaline reaction. It is soluble in 2 parts of water at 60°, and in its own weight at 212°, insoluble in alcohol. It imparts a yellow colour to flame, and dissolves with effervescence (carbonate) in dilute hydrochloric acid, forming a solution which does not precipitate with perchloride of platinum (absence of potash). By heat it undergoes aqueous fusion (*i.e.*, fuses in its abundant water of crystallisation), and then dries up (see Sodæ carb. exsiccata), losing 63 per cent. of its weight. Supersaturated with nitric acid it precipitates only slightly with chloride of barium or nitrate of silver (a trace of sulphate or chloride). 143 grains require for neutralisation at least 960 gr. measures of the volumetric solution of oxalic acid; 20 grains neutralise 9·7 of citric acid and 10½ of tartaric acid. It is distinguished from the bicarbonate by giving a *yellow* (HgO) and not a brick-red precipitate with corrosive sublimate.

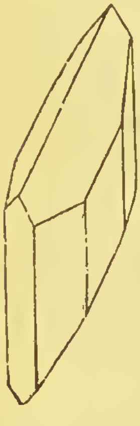

Fig 31.

For other properties of the carbonates see p. 98.

Incompatibilities.—Acids, acidulous salts, chloride of ammonium (see p. 113), lime water, earthy (*e.g.*, sulphate of magnesia) and metallic salts.

Action.—It agrees with carbonate of potash in its action and medicinal properties, but it is not so strong. Excepting as an antidote in poisoning by acids, and as a constituent of effervescing draughts where much carbonic acid is objectionable, it is not used internally, the bicarbonate being in every other respect much more suitable.

Dose.—10 to 60 grains. For effervescing draughts, 20 grs. = 10 grs. of citric or tartaric acids and 2½ fluid drachms of lemon juice.

Antidotes.—Fixed Oil, Vinegar, Lemon juice, Cream of Tartar.

Pharmaceutical Uses.—In the preparation of Sodæ carbonas exsiccata, Liquor sodæ, Liquor sodæ chloratæ, Soda tartarata, Sodæ arsenias, Sodæ bicarbonas, Sodæ phosphas.

1. **Sodæ Carbonas exsiccata,** *P.B.* *Dried Carbonate of Soda.*

$NaO,CO_2 = 53$ or $Na_2CO_3 = 106$.

Contains in 100 parts Na_2O 58·49 and CO_2 41·51.

Preparation.—Expose 8 ounces of *crystalline carbonate*, contained in a porcelain capsule, to a strong heat by means of a sand-bath, until the liquid which first forms is converted into a dry cake. Having rubbed this to powder, preserve it in a stoppered bottle. The crystalline carbonate loses 63 per cent. of water, and is reduced to the anhydrous condition. It is necessary to heat the salt to redness, in order that the water may be uniformly expelled. A purer preparation, and one that is more easily powdered, is obtained by heating the bicarbonate to redness.

Uses.—This is a convenient preparation when we wish to combine a little alkali with vegetable powders, such as calumba and rhubarb.

Dose.—5 to 10 grains, in powder or in pills.

SODÆ BICARBONAS, *P.B.* *Bicarbonate of Soda.*

$NaO,HO,2CO_2 = 84$ or $NaHCO_3 = 84$.

Hydrosodic Carbonate. F. *Bicarbonate de Soude.* G. *Zweifach Kohlen saures Natron.*

Bicarbonate of soda exists in some mineral springs highly acidulated with carbonic acid, as in those of Vichy (see p. 40).

This is obtained on a large scale by moistening the crushed crystals of carbonate of soda, and exposing them on cloths to the depth of 2 or 3 inches, in boxes, to a current of carbonic acid. The gas is absorbed with the extrication of heat and the water of crystallisation. The Pharmacopœia directs it to be prepared as follows:—

Preparation.—Carbonic acid is slowly disengaged by means of the apparatus employed in the preparation of Potassa bicarbonas (see p. 129), and passed similarly under pressure into a mixture of 2 pounds of *carbonate of soda* and 3 pounds of *dried carbonate soda*. When the damp powder has ceased to absorb carbonic acid it is shaken for half an hour with half its weight of water, the undissolved portion is then drained, and dried by exposure to the air on filtering paper placed on porous bricks. An equivalent of carbonate combines with an equiv. each of water and carbonic acid to form 2 equivs. of bicarbonate: $Na_2CO_3 + H_2O + CO_2 = 2NaHCO_3$. When the crystallised carbonate is used alone the CO_2 disengages enough water from it to dissolve the bicarbonate and lead to its crystallisation on the apparatus, a due proportion of dried carbonate is therefore mixed with it to prevent this. The powder is finally washed with a little water, in order to remove any undecomposed carbonate. The bicarbonate of soda of commerce is usually a pure salt, but is occasionally mixed with a little carbonate.

Characters and Tests.—In powder or small opaque irregular scales, white, of a saline, not unpleasant taste. Imparts a yellow colour to flame (soda). Dissolves with much effervesence (CO_2) in dilute hydrochloric acid, forming a solution in which perchloride of platinium causes no precipitate (absence of potash and ammonia). A solution of the salt in cold water gives a white precipitate ($HgCO_3$) and not a coloured (HgO), with a solution of perchloride of mercury (proving the absence of carbonate); with heat, or if the mercurial solution be added to the sodic one, a brick-red precipitate of oxychloride ($2HgO,HgCl_2$). When supersaturated with nitric acid, its solution scarcely precipitates with chloride of barium or nitrate of silver (a trace of sulphates and chlorides). Exposed to a red heat, a molecule, or 84 grains, loses a molecule each of CO_2 and H_2O, and a molecule of anhydrous carbonate = 53 grains, remains, which requires for neutralisation 1000 gr. measures of the volumetric solution of oxalic acid. 20 grains of bicarbonate of soda neutralise 16·7 grains of citric acid, or 17·8 grains of tartaric acid. Bicarbonate of soda is wholly soluble in 10 parts of water, and the solution yields, on spontaneous evaporation, rectangular prisms, which effloresce slightly in the air. If the aqueous solution be heated, 4 molecules of the salt lose 1 of CO_2, and are converted into *sesquicarbonate*—$4NaHCO_3 = 2Na_2CO_3,H_2CO_3 + H_2O + CO_2$; and by continued boiling it is further reduced to monocarbonate—$2NaHCO_3 = Na_2CO_3 + H_2O + CO_2$; the same result as when the dry salt is heated, only more slowly effected.

Incompatibilities.—The same as those of the carbonate. Sulphate of magnesia, however, causes no precipitate, and may therefore be prescribed with it.

Action and Uses.—Free carbonate of soda is a constituent of both the blood and the bile, and the normal reactions of the secretions of the serous membranes and other fluids of the body is alkaline, from the presence of alkaline salts of soda. The bicarbonate may therefore be regarded as *restorative* when the soda salts are deficient in the body. As the carbonate is readily absorbed into and eliminated from the blood, it possesses, in the first place, powerful *antacid* properties, and by forming soluble compounds with the organic acids, such as uric and lactic, and thus facilitating their separation from the body, it has, in the second place, an *eliminative* action. The presence of a minute quantity of carbonate of soda in the blood or fluid of the cells induces free endosmosis; while the presence of acids reverses this action; from which it may be inferred that the presence or absence of carbonate of soda in the blood and animal fluids exercises an important influence on the physical as well as the chemical actions of the body. Generally the action of bicarbonate of soda corresponds with that of potash (see p. 130); but while it is less irritant and less penetrating, it has a greater neutralising power, due to the larger percentage of alkali.

It is very usefully employed in lithiasis (uric acid), acid dyspepsia, gout, rheumatism, and as an antacid and diuretic.

Dose.—10 to 60 grains. 20 grs. neutralise 16·7 and 17·8 grs. of citric and tartaric acids respectively.

Pharmaceutical Uses.—In the preparation of the four articles following, three of which are officinal:—

1. **Liquor Sodæ Effervescens,** *P.B.* *Effervescing Solution of Soda. Alkaline Soda Water.*

10 fluid ounces contain 15 grains of bicarbonate of soda. Substituting bicarbonate of soda for that of potash, this solution corresponds exactly in strength, mode of preparation, and physical characters, with the Liquor potassæ effervescens (see p. 130).

Test.—10 fluid ounces, after being boiled for five minutes, require for neutralisation 178 gr. measures of the volumetric solution of oxalic acid. The "Soda water" of commerce, it must be remembered, is merely carbonic acid water, and the preparation of the Pharmacopœia may be extemporised by dissolving 15 grains of bicarbonate of soda in ½ an ounce of water, and then adding a half pint bottle of common soda water.

2. **Trochisci Sodæ Bicarbonatis,** *P.B.* *Soda Lozenges.*

Each contains 5 grains of the salt.

Preparation.—Mix together 3600 grs. of *bicarbonate of soda*, 25 ounces of refined *sugar*, 1 ounce of *gum acacia* in powder, and add 2 fluid ounces of *mucilage of gum acacia*, and 1 fluid ounce of *water*, to form a proper mass; divide into 720 lozenges, and dry these in a hot-air chamber with a moderate heat.

Dose.—1 to 6 lozenges.

3. **Sodæ Citro-tartras Effervescens,** *P.B.* *Effervescent Citro-tartrate of Soda.*

Preparation.—Mix thoroughly 17 ounces of *bicarbonate of soda*, 8 ounces of powdered *tartaric acid*, and 6 ounces of powdered *citric acid*; then place the powder in a dish or shallow pan, and heat it to between 200° and 220°, and when the particles of the powder begin to aggregate, stir them assiduously until they assume a granular form; then, by means of suitable sieves, separate the granules of uniform and most convenient size, and preserve the preparation in well-closed bottles.

In the above process the particles of the powder are agglutinated by the water of crystallisation without mutual decomposition, which is only effected by solution in water, when an agreeable effervescing draught is formed. The compound sold as "*Granular Effervescent Citrate of Magnesia*" is the foregoing, combined with a little sulphate of magnesia.

Dose.—1 to 2 drachms in a large draught of water.

4. **Pulveres Effervescentes.** *Soda Powders.*

For these we may take 20 grains of bicarbonate of soda, dissolved in 1½ to 3 ounces of water in a tumbler, adding ½ oz. of lemon juice, or 18 grs. of tartaric or citric acid, dissolved in a little water, and drink while in a state of effervescence: a citrate or tartrate of soda will be formed. By adding 1 or 2 drachms of Rochelle salt, or sulphate of magnesia, an aperient salt may be presented in the agreeable form of an effervescing draught. It must be remembered that citrates and tartrates become converted into carbonates, and will, if long taken, produce an alkaline condition of the secretions.

SODII CHLORIDUM, *P.B.* *Chloride of Sodium.*

$NaCl=58{\cdot}5$ or $\mathbf{NaCl}=58{\cdot}5$.

Sodic Chloride. Common Salt. Muriate of Soda. Sal Fossile. Sal Marinum. Sal Gemmæ. F. *Chlorure de Sodium.* G. *Chlor. Natrium.*

Contains in 100 parts **Na** 39·32; **Cl** 60·68.

Common salt is abundantly diffused in nature, and, being an essential article of diet, must have been known from the earliest ages. It is found in all animal solids and fluids, and in the juices of most if not all vegetables. It exists in large quantities in the solid form as *rock salt*, in solution in some springs, and everywhere in sea water. From these waters it is obtained by evaporation, when it crystallises with slight variations of appearance according to differences in the process. These varieties are known by different names in commerce,—as *butter*, *stone*, and *basket salt*, also *sea salt*, and, in large crystals, as *Malden*, *fishery*, and *bay salt.* Most of the kinds of salt require purification, by resolution and recrystallisation; for they are apt to contain alkaline and earthy sulphates and chlorides, especially of magnesium and calcium.

Characters and Tests.—Common salt crystallises in anhydrous and transparent cubes; these are sometimes aggregated together, forming hollow four-sided pyramids, with their sides in steps. It usually occurs in small white crystalline grains. Sp. gr. 2·24; colourless when pure. Taste saline, "*salt;*" odourless; it does not affect either litmus or turmeric. Soluble in 2½ parts of water, and its solubility is not much increased by a boiling temperature. A saturated solution (sp. gr. 1·205) at 229°·5, the boiling point of the solution, contains 41·2 per cent. of the salt. It is insoluble in pure alcohol, but slightly soluble in rectified spirit, to the flame of which it gives a yellow tinge. Salt readily transmits radiant heat. When heated, it decrepitates; at a red heat, fuses and sublimes. Inalterable in the air when pure; but when impure, it deliquesces. Sulphuric and nitric acids decompose salt, and so do boracic and phosphoric, with the assistance of heat. It gives with nitrate of silver a precipitate of chloride of silver, soluble in H_3N, insoluble in HNO_3. It is distinguished from a potash salt by giving no precipitate with chloride of platinum. For other characters, see "Chlorides," p. 88. Scarcely any precipitate should be occasioned by carbonate of soda or nitrate of baryta (the first indicating the absence of earthy salts, and the latter of carbonates and sulphates). It often contains a little sulphate of magnesia, sometimes also chloride of magnesium, by which it is rendered deliquescent. A solution is not precipitated by one of carbonate of ammonia followed by solution of phosphate of soda. The former would detect lime, and the latter, in addition, would indicate magnesia.

Action.—Forming an essential constituent of animal fluids, and furnishing the hydrochloric acid of the digestive juice, chloride of sodium is necessary to life. It is also essential to growth; for it is always accumulated where the nutritive changes and formative processes are taking place. It doubtless happens very rarely that the body is deficient in chlorides of sodium; but since considerable quantities are constantly eliminated by the kidneys and secretions of the mucous membranes, such a condition may exist in states of inanition, or of chronic irritability of the stomach, which prevents the ingestion of sufficient food. In such cases, chloride of sodium would act as a *restorative.* Small doses (from ½ to 1 drachm daily), in various articles of diet, constitute a necessary portion of the diet. It has a *stimulant* action on the mucous membrane, and may be regarded as the natural stimulant of the gastric membrane, promoting appetite, as well as serving the purposes of digestion. Excessive use induces thirst. In large quantities (½ to 2 ounces), salt acts as an *irritant*, causing vomiting and purging. A solution of 1 ounce in a pint of water has been used as an intravenous injection in the collapse attending the last stage of cholera, as a powerful stimulant, and as a means of preserving the fluidity of the blood.

Medicinal Uses and Doses.—As an *emetic*, one or two tablespoonfuls should be given in a tumblerful of warm water, and after a short interval the emesis should be encouraged by drinking warm water freely. As an *enema* (1 ounce in a pint of water or gruel), it is an useful stimulant to the lower bowel, promoting the evacuation of its contents. As an *anthelmintic*, it is serviceable as an enema (½ an ounce in 2 ounces of water), when the worms occupy the descending colon or rectum; the same may be used by the mouth or the bowel, if a leech should have accidentally passed-in either way. As a stimulant to the cutaneous circulation, it is useful in the form of a bath (a pound of salt to every 3 gallons of water will make a bath of the strength of sea water). A bag of hot salt is a convenient means of applying dry heat to any part of the body. Chloride of sodium is the appropriate antidote in poisoning by nitrate of silver; and in applying this caustic to a surface in contact with another,—for example, the eyelid and the cornea,—the latter should be protected from the action of the caustic by brushing a solution of salt (5 grains to 1 fluid drachm) over the surface to which the caustic has been applied, before the part is released by the fingers.

LIQUOR SODÆ CHLORATÆ, *B.P.* *Solution of Chlorinated Soda.*

Hypochlorite of Soda. *Chloride of Soda.* F. *Chlorure de Soude.* G. *Chlornatron.*

This is a mixed solution of hypochlorite of soda, chloride of sodium, and bicarbonate of soda. It was introduced in 1822 by M. Labarraque as a disinfecting fluid.

Preparation.—It is prepared by passing a stream of *chlorine* (generated slowly from a mixture of 4 ounces of black oxyde of manganese in powder, and 15 fluid ounces of hydrochloric acid), washed in 4 ounces of water, through a solution of 12 ounces of *carbonate of soda* in 36 fluid ounces of water. Hypochlorite of soda, chloride of sodium, and bicarbonate of soda are formed and remain in solution, thus:—$2Na_2CO_3+Cl_2+H_2O=NaClO+NaCl+2NaHCO_3$.

The liquid must be preserved in a cool and dark place. Its essential properties depend on the hypochlorite of soda.

Characters and Tests.—A colourless alkaline liquid; sp. gr. 1·103, with astringent taste and feeble odour of chlorine. It decolorises sulphate of indigo. It effervesces with hydrochloric acid, evolving chlorine and carbonic acid, and forming a solution which does not precipitate with perchloride of platinum (absence of potash and ammonia). It is not precipitated by oxalate of ammonia (absence of lime). 70 grains added to a solution of 20 grains of iodide of potassium, in 4 fluid ounces of water acidulated with 2 fluid drachms of hydrochloric acid, require for the discharge of the brown colour (free iodine) which the mixture assumes, 500 gr. measures of the volumetric solution of hyposulphite of soda.

Hydrochloric acid forms hydriodic acid by its action on the iodide of potassium, $HI+HCl=KCl+HI$. Hypochlorous acid is liberated by another portion of the hydrochloric acid, and the reaction lies between the hydriodic and the hypochlorous acid, the latter oxydising the hydrogen of the former, and setting free its iodine, thus: $HClO+2HI=HCl+H_2O+I_2$. The decolorising effect of the hyposulphite of soda (see pp. 160, 161) measures the quantity of iodine set free; and this is determined by the quantity of hypochlorite present in the solution, the hydriodic acid itself being in excess.

If instead of carbonate of soda we employ carbonate of potash, we shall have the *Eau de Javelle* or *chlorinated potash*, first employed in bleaching in 1789, but little used in medicine.

Action.—The hypochlorites are decomposed by the feeblest acids, even carbonic, hypochlorous acid being set free. This again is a most unstable product, very readily imparting its oxygen both to mineral and organic substances (see above). Hypochlorite of soda itself, when brought in contact with secondary organic compounds of the body, urea, uric acid, hippuric acid, kreatinine, &c., even at a temperature of 60°, causes their complete decomposition. Urea immediately splits up into nitrogen, carbonic acid, and water, thus: $CO(NH_2)_2 + 3HClO = N_2 + CO_2 + 2H_2O + 3HCl$. If, therefore, the hypochlorite of soda meet with no acid in the stomach it will doubtless be absorbed as such into the blood, and decompose such organic compounds as may be present in it. If it meet with much acid in the stomach, hypochlorous acid will be at once set free, and this may undergo decomposition in the stomach, or be absorbed into the blood, whence its action would be probably identical with that of the hypochlorite. Such, in the absence of positive facts, may be accepted as the theory of its action. In fever there is an accumulation of imperfectly oxydised matters in the blood, and in some diseases an accumulation of the essential constituents of the urine and bile, and the beneficial influence of hypochlorite of soda in putrid fevers may be due to its conversion of these into properly oxydised products which are capable of being excreted—a conversion, it may be of a colloid, which is incapable of permeating the wall of a capillary into a crystalloid, which readily passes through the wall of the blood-vessel. The bleaching action of hypochlorous acid is twice as powerful as that of chlorine.

Medicinal Uses and Doses.—Disinfectant, antiseptic, stimulant, antacid. In diphtheria, malignant scarlet fever, &c., it may be given in doses of 10 to 30 minims in a little aromatic water. In poisoning by sulphide of hydrogen and hydrocyanic acid it is an appropriate antidote. In putrid ulcerations of the mouth or throat, as a wash or gargle diluted with 15 parts of water. As an injection or lotion in offensive vaginal discharges, cancerous, and phagedenic ulcerations.

Cataplasma Sodæ Chloratæ, *P.B.* *Chlorine Poultice.*

Mix 4 ounces of linseed meal with 8 ounces of boiling water, and add 2 ounces of solution of chlorinated soda, stirring constantly.

Use.—An excellent application to foul sores and sloughing ulcers.

BORAX, *P.B.*

$NaO,2BO_3 + 10HO = 101 + 90$ or $Na_2B_4O_7,10H_2O = 202 + 180$.

Biborate of Soda. Sodæ Biboras. F. *Borax.* G. *Boraxsaures Natron.*

Contains in 100 parts Na_2O, 16·23; B_2O_3, 36·65; H_2O, 47·12; is supposed to have been known to the ancients, and to have been the

Chrysocolla of Pliny. The Hindoos have long been acquainted with it; it is their *Sohaga*, Sanscrit *Tincana*, and one of the kinds of *Booruk* of the Arabs. Its nature was first ascertained by Geoffroy in 1732. It is produced by spontaneous evaporation on the shores of some lakes in Thibet, brought across the Himalayan Passes into India, and imported into this country by the names of *Tincal* and *Crude Borax.* It is also obtained by saturating the boracic acid of Tuscany (p. 67) with carbonate of soda.

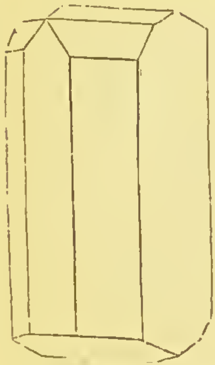

Fig. 32.

Crude borax is in pale greenish pieces, covered with an earthy coating, and feels greasy to the touch. The natives of Thibet are said to cover it with some fatty matter, to prevent its destruction by efflorescence. It is purified by calcining, which destroys the fatty matter, or by washing with an alkaline ley, which converts it into a soap, then dissolving and re-crystallising.

Characters and Tests.—Pure borax forms transparent colourless rectangular or six-sided prisms, of feebly alkaline taste and reaction, sometimes slightly effloresced; soluble in 12 parts of cold and 2 parts of boiling water; insoluble in alcohol. A hot saturated solution, when acidulated with any of the mineral acids, lets fall as it cools a scaly crystalline deposit (boracic acid), the solution of which in spirit burns with a green flame. 191 grains dissolved in 10 fluid ounces of water require for saturation 1000 gr. measures of the volumetric solution of oxalic acid. When heated, borax loses water, swells up into a porous substance called *borax usta*, and at a red heat runs into transparent glass, called *glass of borax*, much used as a flux on account of its solvent power over the metallic oxydes. Another variety, more useful in the arts, contains only 5 eqs. aq., and crystallises in octohedra, which are permanent in the air. Borax increases the solubility of cream of tartar (p. 141), and converts mucilage of lichen and of salep into a thick jelly.

Incompatibilities.—Acids, acid salts.

Action.—Borax has no specific action on the system; it is eliminated by the kidneys unchanged; is antacid, detergent, and destructive of fungi. It is supposed to be emmenagogue. It possesses the properties of an alkali, forms a lather with oil, and decomposes chloral hydrate.

Medicinal Uses.—Curative in Stomatitis fungosa (aphthæ), and in Epidermycosis versicolor (liver spot). It is applied locally to the first effection mixed with honey or glycerine, and to the latter as a lotion (a saturated aqueous solution), and generally to irritable excoriations and crackings of the skin. As a detergent wash for the head. Internally, it is beneficial in the uric acid lithiasis.

Dose.—5 to 30 grains, 1 part in 24 of water as a lotion.

1. **Glycerinum Boracis**, *P.B.* *Glycerine of Borax.*

Preparation.—Rub 1 ounce of *borax* in powder, with 4 fluid ounces of *glycerine* until dissolved.

Uses.—Applied to aphthous ulcers and eruptions, such as acne. Used as an ingredient in cooling lotions.

2. **Mel Boracis**, *P.B.* *Honey of Borax.*

Preparation.—Mix 64 grains of finely powdered *borax* with 4 ounces of clarified *honey.*

Uses.—Applied to aphthous ulcers of the mouth.

SODÆ SULPHAS, *P.B.* *Sulphate of Soda.*

$NaO,SO_3+10HO=71+90$ or $Na_2SO_4,10H_2O=142+180$.

Sodic Sulphate. *Natrum Vitriolatum.* *Glauber's Salts.*
F. *Sulphate de Soude.* G. *Schwefelsaures Natron.*

Contains in 100 parts Na_2O, 19·25; SO_3, 24·84; H_2O, 55·91.

Sulphate of soda, or Glauber's salt, is found effloresced on the soil in some countries, as in India, where it is called *kharee nimuk* or *kharee noon.* It occurs in large masses in the mountains of the Ebro valley, and near Aranjuez in Spain. It exists in sea water, in that of some lakes and mineral springs, also in glauberite. It is found in the ashes of many plants, and in some animal secretions.

It is usually obtained from the residue (acid sulphate of soda, $NaHSO_4$) left in the manufacture of hydrochloric acid from common salt (see p. 91), by neutralising it with carbonate of soda, and crystallising the solution. Large quantities are prepared as "salt cake," in the manufacture of carbonate of soda.

Characters and Tests.—Transparent, but very efflorescent; long four-sided prisms, terminated by dihedral summits; of a saltish and bitter taste; soluble in 3 parts of water at 60°, and in its own weight of water at 212°. The solubility of sulphate of soda in water is anomalous, as it increases up to 92°, and then diminishes to 215° at which point it is only as great as that at 87°. Insoluble in alcohol. Exposed to heat in a porcelain crucible, it loses 55·9 per cent. of water; and the same complete dehydration is effected more slowly by mere exposure to the air—such is its efflorescent power. Heated with solution of potash no odour of ammonia is evolved, and no precipitate is formed (absence of iron and manganese). Imparts a yellow colour to flame. 100 grains dissolved in water, and acidulated with hydrochloric acid, give, by the addition of chloride of barium, a white precipitate (sulphate of baryta), which when it has been washed and dried weighs 72·2 grains (proving the proper proportion of sulphuric acid). Sulphate of soda is not liable to adulteration. The anhydrous variety crystallises in rhombic octohedra.

Incompatibilities.—Salts of baryta, lime, and lead, which precipitate their insoluble sulphates. With potassic carbonate, sulphate of potash and carbonate of soda are formed.

Action.—Passing into the blood, it exercises a solvent action on its fibrin. When large doses are taken the salt is eliminated for the most part unchanged, and with a large quantity of water by the intestinal mucous membrane. In smaller quantities it is partly eliminated by the kidneys, as indicated by an increase in the sulphates of the urine. Some portion of the salt is decomposed, and the sulphur deoxydised, for H_2S is excreted by the alimentary canal. Sulphate of soda is the essential constituent of Cheltenham, Leamington, and other mineral waters (see p. 42).

Dose.—$\frac{1}{2}$ to 2 ounces in a tumblerful of water.

Sulphites of Soda.—1. *The acid sulphite*, $NaHSO_3,4H_2O$, is obtained by passing an excess of washed sulphurous acid through a solution of one part of crystallised carbonate of soda in two parts of water, and crystallising from the concentrated solution. 2. *The neutral* or *normal sulphite*, $Na_2SO_3,10H_2O$, is prepared from the former by saturating it with carbonate of soda, and evaporating to form crystals.

The mineral acids decompose these compounds, with the evolution of sulphurous acid.

Action and Uses.—These soluble salts have the same action. Sulphurous acid is liberated from them by the acid of the stomach; and as it destroys the vegetable organisms on which fermentation depends, these salts are very useful in diseases of the stomach, which are either due to *sarcina ventriculi*, or are associated with its presence. In large doses, they are purgative.

Dose.—$\frac{1}{2}$ to 1 drachm as an antiferment, and 2 to 4 drachms as a purgative.

HYPOSULPHITE OF SODÆ, *P.B.*

$NaOS_2O_2,5HO = 124$ or $Na_2H_2S_2O_4,4H_2O = 248$.

This salt is prepared by digesting a solution of the sulphate of soda with sulphur at a gentle heat for several days. The sulphur gradually disappears, and a colourless solution *of hyposulphite is formed:* $Na_2SO_3 + H_2O + S = Na_2S_2H_2O_4$. The liquid is filtered and evaporated, when large colourless rhombic prisms with oblique facets crystallise.

Hyposulphite of soda, in common with the other soluble hyposulphites, dissolves argentic chloride with decomposition, an atom of silver displacing an atom of sodium, which combines with the liberated chlorine. The resulting argentic sodic hyposulphite forms an intensely sweet solution: $AgCl + Na_2H_2S_2O_4 = NaCl + NaAgH_2S_2O_4$. The mineral acids decompose hyposulphite of soda, with the separation of sulphur and the evolution of sulphurous anhydride.

Tests.—24·8 grains decolorise 100 gr. measures of the volumetric solution of iodine, two atoms of iodine removing two each of sodium and water from two of the hyposulphite, and converting it into tetrathionate, thus: $2Na_2H_2S_2O_4 + I_2 = 2NaI + Na_2S_4O_6 + 2H_2O$.

Action and Uses.—Those of sulphites of soda, instead of which it is usually employed. It is largely used on the Continent in the treatment of skin diseases. Its properties, as a local application, are those of sulphurous acid.

Pharmaceutical Uses.—To estimate the proportion of free iodine and chlorine in certain solutions, see the following:—

1. **Volumetric Solution of Hyposulphite of Soda**, 1000 gr. measures contain 24·8 grains.

Preparation.—Dissolve 280 grains of the crystallised hyposulphite (an excess) in 10,000 gr. measures of water. Fill a burette with the solution, and drop it cautiously into 1000 gr. measures of the volumetric solution of iodine until the brown colour is just discharged. Note the number of gr. measures (n) required to produce this effect; then put 8000 gr. measures of the hyposulphite solution into a graduated jar, and increase this quantity by the addition of water until it amounts to $\frac{8000 \times 1000}{n}$ gr. meas. If, for example, $n = 950$, the 8000 gr. meas. of the solution should be diluted to the bulk of $\frac{8000 \times 1000}{950} = 8421$ gr. measures. 1000 gr. measures of this solution contain 24·8 grs. of the hyposulphite ($= \frac{1}{10}$ of $2(NaO,S_2O_2 + 5HO)$ or $\frac{1}{10}$ of $\mathbf{Na_2H_2S_2O_4,4H_2O}$ in grains), and therefore correspond to 12·7 grains of iodine ($= \frac{1}{10}$ of an equivalent in grains).

Grammes and cubic centimetres may be used instead of grains and gr. measures, $\frac{1}{10}$ of the numbers being taken for convenience. 100 cubic centimetres of this solution contains 2·48 grammes of the hyposulphite ($= \frac{1}{100}$ of $2(NaOS_2O_2 + 5HO)$ or $\frac{1}{100}$ of $\mathbf{Na_2H_2S_2O_4,4H_2O}$, in grammes), and therefore correspond to 1·27 grammes of iodine ($= \frac{1}{100}$ of an equivalent in grammes). This solution is used for testing the following substances:—

	Grains.		Gr. meas.		Grammes.		Cubic centim.
Calx chlorata,	10·0	require	850	or	1·00	requires	85·9
Iodinium,	12·7	,,	1000	,,	1·27	,,	100·0
Liq. calcis. chloratæ.	60·0	,,	500	,,	6·00	,,	50·0
Liquor chlori,	439·0	,,	750	,,	43·90	,,	75·0
Liq. sodæ chloratæ.	70·0	,,	500	,,	7·00	,,	50·0

In each case, excepting that of iodine, a solution of iodide of potassium and hydrochloric acid are added to the substance, and the amount of iodine so liberated is indicated by this solution.

SODÆ NITRAS, *P.B.* *Nitrate of Soda.*

$NaO,NO_5 = 85$ or $\mathbf{NaNO_3} = 85$.

Cubic Nitre. Chili Saltpetre.

This salt is found just below the surface of the soil near Iquique, in Peru.

Characters and Tests.—In colourless obtuse rhombohedral crystals having a cooling saline taste, slightly deliquescent, soluble in about 2 parts of cold water. Thrown on the fire it deflagrates. Warmed in a test tube with sulphuric acid and copper wire, it evolves ruddy fumes. The solution gives no precipitate with nitrate of silver, or chloride of barium—possessing, in short, the characters of nitrate of potash, from which it is distinguished by the tartaric acid and platinum tests (see "salts of potassium," p. 121).

Uses.—Medicinally, it may be substituted for nitrate of potash. *Pharmaceutically*, it is employed in the preparation of arseniate of soda.

SODÆ PHOSPHAS, *P.B.* *Phosphate of Soda.*

$2NaO,HO,PO_5+24HO=142+216$ or $Na_2HPO_4 12H_2O=142+216$.

Rhombic Phosphate of Soda. *Sal Mirabile perlatum* or *Common Tribasic Phosphate of Soda.* F. *Phosphate de Soude.* G. *Phosphorsaures Natron.*

Contains in 100 parts 39·6 Na_2HPO_4 and 60·3 H_2O.

This salt was introduced into practice by Dr Pearson about 1800. It was found in urine by Hellot in 1737, and analysed by Marcgraff in 1745. It is also found in the serum of blood, and in other animal secretions; it is obtained from bone ashes.

Preparation.—It is obtained by neutralising a solution of superphosphate of lime (see p. 62) at the boiling point with a solution of carbonate of soda until the fluid has acquired a feeble alkaline reaction. After filtration from the insoluble phosphate of lime the fluid is evaporated till a film forms on the surface, and set aside to crystallise. On the addition of carbonate of soda to the soluble superphosphate, bibasic phosphate of lime is precipitated and tribasic-phosphate of soda formed, water and carbonic acid being liberated, thus: $CaH_4 2PO_4+Na_2CO_3=CaHPO_4+Na_2HPO_4+H_2O+CO_2$. A slight excess of carbonate of soda promotes the crystallisation. The crystals should be dried rapidly and without heat (on account of their tendency to effloresce) on filtering paper or porous bricks, and be preserved in stoppered bottles.

In large, colourless, transparent, oblique rhombic prisms, efflorescent, of a cool saline taste. Sp. gr. 1·58. Soluble in four parts of cold water. At 99° the crystals fuse in their water of crystallisation, and are therefore soluble in any quantity of boiling water; insoluble in alcohol. When heated to 302° the salt is obtained in the anhydrous condition (N_2HPO_4), a hard white mass, but on resolution in water again forms the rhombic phosphate, and at a red heat melts into a greenish-coloured glass, opaque when cool. This is the *pyrophosphate* ($Na_4P_2O_7$) formed by the loss of basic water, $2Na_2HPO_4=Na_4P_2O_7+H_2O$. Solution of phosphate of soda has a slight alkaline reaction, and corrodes flint glass bottles, causing the separation of silicious flakes. It imparts a yellow colour to flame (sodium), and gives a yellow precipitate (Ag_3PO_4) with nitrate of silver, the resulting fluid acquiring an acid reaction (from liberation of nitric acid:—$Na_2HPO_4+3AgNO_3=Ag_3PO_4+2NaNO_3+HNO_3$). Heated to dull redness it loses 63 per cent. of its weight (water of crystallisation and basic water), leaving a residue (pyrophosphate) which, when dissolved in water, gives with chloride of barium a precipitate (pyrophosphate of baryta) almost entirely soluble in diluted nitric acid (a slight residue indicating the presence of a little sulphuric acid). (For other characters see phosphates, p. 65.)

Incompatibilities.—Salts of lime, magnesia, baryta, alumina, and metallic salts generally, are precipitated as phosphates. If ammonia be present in the solution of the salts of magnesia, colourless prisms of ammonio-magnesic phosphate ($MgH_4NPO_4,6H_2O$) are formed.

Action.—Earthy and alkaline phosphates are normal constituents of the blood and animal tissues and juices, and may therefore be considered as *restorative* in states of prolonged anorexia and inanition if the urine should indicate a deficiency. Large quantities are constantly excreted. According to Enderlin, the ash of the fæces contains 85·7 per cent. of phosphates, 2·8 of which is phosphate of soda. The urine in a state of health contains nearly 1 per cent. of the alkaline and earthy phosphates. The influence of phosphate of soda on the system in a state of health is not appreciable unless it be given in large doses, when it acts, *mutatis mutandis*, like the sulphate, producing watery evacuations from the bowels and an increase of phosphates in the urine.

Medicinal Use and Dose.—As a mild purgative in doses of ½ to 1½ ounce. It is preferable to other saline aperients on account of its milder action and unobjectionable taste.

Pharmaceutical Uses.—In the preparation of Ferri phosphas, Syrupus ferri phosphatis, and the following:—

1. **Solution of Phosphate of Soda.** *P.B.* = 1 ounce of the salt in 10 fluid ounces of water. It is used as a test for the presence of salts of lithium.

SODÆ PHOSPHITIS. *Phosphate of Soda.*

$NaO,PO_3,11HO$, or $Na_2PHO_3,5H_2O$.

This is a soluble crystalline salt, formed by the mutual reaction of carbonate of soda and phosphite of lime.

Action and Uses.—See the following.

Dose.—15 to 30 grains.

SODÆ HYPOPHOSPHIS, *P.B.* *Hypophosphite of Soda.*

$NaO,PO,2HO$ or $NaPH_2O_2$.

This salt is obtained by adding carbonate of soda to a solution of hypophosphite of lime (see p. 66), as long as precipitate of carbonate of lime is formed: $Ca2PH_2O_2 + Na_2CO_3 = CaCO_3 + 2NaPH_2O_2$. The filtered solution is evaporated to dryness by the heat of a steam bath, keeping it constantly stirred when the salt begins to solidify.

Characters and Tests.—A white granular salt, having a bitter, nauseous taste. It is deliquescent, very soluble in water and in spirit, but insoluble in æther. At a red heat it ignites, emitting spontaneously inflammable phosphuretted hydrogen (phosphate of soda remaining, thus: $2NaPH_2O_2 = H_3P + Na_2HPO_4$). For other characters of the Hypophosphites, see p. 66.

Action and Uses.—This and the preceding salt have been empirically set forward as nervine stimulants; and if at any time the nervous system should be over-stimulated or exhausted by excessive oxygenation of the blood, they may claim a function. The deoxydising action of the phosphites is illustrated by the reduction of sulphurous acid to sulphuretted hydrogen, and that of the hypophosphites by the reduction of the salts of the less oxydisable metals to the metallic condition. If phthisis and scrofula were due (as they are not) to hyperoxydation of the blood, the salts in question would undoubtedly be proper remedies.

Dose.—2 to 5 grains.

SODA TARTARATA, *P.B.* *Tartarated Soda.*

$NaO,KO,C_8H_4O_{10}+8HO = 210+72$ or $NaKC_4H_4O_6,4H_2O = 210+72$.

Sodæ et Potassæ Tartras. *Sodæ-Potassio-Tartras. Tartrate of Potassium and Sodium. Rochelle Salt.* F. *Tartrate de Potasse et de Soude.* G. *Weinsaures Natron Kali.*

Tartrate of soda and potash was discovered in 1672 by Seignette, an apothecary of Rochelle. Hence it is called *Sel de Seignette* and Rochelle Salt.

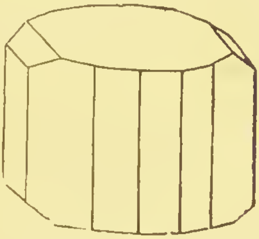

Fig. 33.

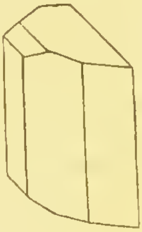

Fig. 34.

Preparation.—By displacing the atom of basic water from acid tartrate of potash by soda. To effect this 12 ounces of *carbonate of soda* are dissolved in 4 pints of *water*, and to this 16 ounces of *acid tartrate of potash* are added; when carbonic acid escapes, the solution is boiled for a few minutes and neutralised by one or other of the ingredients, if either acid or alkali prevail. It is again boiled, filtered, and concentrated till a pellicle forms on the surface and crystallised, $2KHC_4H_4O_6 + Na_2CO_2 = 2KNaC_4H_4O_6 + H_2O + CO_2$.

Characters and Tests.—In large, colourless, transparent right rhombic prisms, with 10 or 12 parallel but unequal surfaces (fig. 33), or in half prisms having six parallel surfaces, one of which is twice as broad as any of the others (fig. 34). Taste saltish and bitterish; soluble in 5 parts of water at 60°. They slightly effloresce in a dry air, and, when heated, melt in their water of crystallisation. It blackens like the other tartrates and the citrates, evolving inflammable gases and the odour of burnt sugar. It imparts a yellow colour to flame (soda). A strong solution gives a crystalline precipitate with a small quantity of acetic acid (potassium—the acid neutralises the soda, and acid tartrate is precipitated). Entirely soluble in cold water. 141 grains heated to redness till gases cease to be evolved, leave an alkaline residue (carbonates of potash and soda mixed with carbon), which requires for neutralisation 1000 gr. measures of the volumetric solution of oxalic acid.

Incompatibilities.—Acids and acidulous salts precipitate the acid tartrate, salts of lime, baryta, and the metallic salts generally are precipitated as tartrates, except in some cases when the solutions are very diluted.

Action.—Similar, if not identical, with that of tartrate of potash (see p. 139), than which its alkalising action is a little stronger.

Uses and Doses.—30 to 60 grains act as a diuretic, rendering the urine alkaline; $\frac{1}{4}$ to $\frac{1}{2}$ ounce, a mild aperient. It is a suitable aperient in the febrile state, and acts as a good supplement to stronger purgatives.

With a little free soda and tartaric acid it forms the well-known and useful *Seidlitz powder*, which is composed of a mixture of 120 grains of Rochelle salts and 40 grains of carbonate of soda in the blue paper, and 37 grains of tartaric acid in the white.

SODÆ ACETAS, *Acetate of Soda.*

$NaO,C_4H_3O_3+6HO=82+54$ or $NaC_2H_3O_2,3H_2O=82+54$.

F. *Acetate de Soudè.* G. *Essigsaures Natron.*

This salt is prepared on a large scale by saturating impure pyroligneous acid with chalk or slaked lime. The acetate of lime thus formed is decomposed by the requisite quantity of sulphate of soda. Insoluble sulphate of lime is precipitated, and acetate of soda remains in solution.

Characters and Tests.—In transparent, colourless, oblique rhombic prisms of cooling, saline, bitterish taste; sp. gr. 2·1; soluble in 3 parts of water at 60°, and in its own weight at 212°; soluble in 24 parts of alcohol. The aqueous solution is neutral. When diluted it is not precipitated by chloride of barium or nitrate of silver (absence of sulphates and chlorides, the acetates of barium and silver being moderately soluble). Exposed to dry air it effloresces, losing about 40 per cent. of water. Heat cautiously applied likewise expels the water of crystallisation, and at 600° the salt is decomposed, and at a red heat is converted into carbonate of potash, mixed with a little carbon.

Incompatibilities.—The strong acids which displace the acetic (see acetates).

Action.—Similar to that of acetate of potash, for which it may be used.

Medicinal Uses and Doses.—As a diuretic or sudorific, 20 grains to 2 drachms; as a purgative, 2 to 4 drachms.

Pharmaceutical Uses in the preparation of the following:—Ferri arsenias, Ferri phosphas, Syrupus ferri phosphatis, and as

1. **Solution of Acetate of Soda,** *P.B.* = 1 ounce of the salt in 10 fluid ounces of water, is employed for indicating the constituents of phosphate of lime.

SODÆ VALERIANAS, *P.B.* *Valerianate of Soda.*

$NaO,C_{10}H_9O_3$ or $NaC_5H_9O_2$.

Preparation.—Dilute 6½ fluid ounces of *sulphuric acid* with 10 fluid ounces of *water*, and dissolve 9 ounces of *bichromate of potash* in 3½ pints of hot water. When both liquids are cold, mix them with 4 fluid ounces of *amylic alcohol* (fousel oil, $C_5H_{12}O$) in a matrass, with occasional brisk agitation, until the temperature of the mixture has fallen to about 90°. Connect the matrass with a condenser, and distil until about half a gallon of liquid has passed over. Saturate the distilled liquid accurately with *solution of soda*, remove any oil which floats on the surface, evaporate till watery vapour ceases to escape, and then raise the heat cautiously so as to liquefy the salt. When it has cooled and solidified, break it into pieces, and immediately put it into a stoppered bottle.

By the action of sulphuric acid on the bichromate, chromic acid CO_3 is liberated. This powerful oxydising agent converts the amylic alcohol into valerianic acid, in the same way that it converts ordinary alcohol into acetic acid; the chromium of the chromic acid and the potassium uniting with the sulphuric acid, which is in excess, to form chrome alum, a double sulphate of chromium and potash, thus:—$2K_2Cr_2O_7 + 3C_5H_{12}O + 8H_2SO_4 = 3HC_5H_9O_2 + 11H_2O + (K_2SO_4Cr_23SO_4)$.

The valerianic acid thus formed acts upon an unchanged portion of the amylic alcohol, giving rise to valerianate of amyl, which is converted by the soda into valerianic acid and amylic alcohol, and thus a portion of the amylic alcohol is regenerated.

Characters.—In dry white masses without alkaline reaction, entirely soluble in rectified spirit, and giving out a powerful odour of valerian on the addition of sulphuric acid.

Action and Uses.—See Valerianate of zinc.

Dose.—1 to 5 grains.

Pharmaceutical Use.—In the preparation of valerianates of zinc and iron.

LITHIUM: L = 7 or **L** = 7.

This is the lightest solid body known, sp. gr. 0·59, and floats in naphtha. It was discovered by Arfwedson in 1818, and occurs in the minerals petalite and lepidolite, obtained from Sweden, in Triphane, and in many mineral waters (see p. 42, &c.)

Lithia ($LO = 15$ or $L_2O = 30$) is a white caustic substance, less soluble in water than potash or soda, not deliquescent, but absorbing CO_2 from the air. It requires a larger proportion of acid to neutralise it than the other alkalies. For the characters of salts of lithia, see the following:—

LITHIÆ CARBONAS, *P.B.* *Carbonate of Lithia.*

$LO,CO_2=37$ or $L_2CO_3=74$.

Preparation.—Sulphate of lithia is obtained by acting on *petalite* or *lepidolite* with sulphuric acid, heating to redness, and dissolving the residue. From a strong solution of the sulphate the carbonate is precipitated by adding carbonate of ammonia. It may be crystallised by solution in hot water, and cooling.

Characters and Tests.—This salt occurs in crystalline grains, or a white powder. It has an alkaline reaction; requires 100 parts of water at 60° for solution. It is insoluble in alcohol.

It dissolves with effervescence in hydrochloric acid; the solution evaporated yields chloride of lithium, which communicates a red colour to the flame of a spirit lamp, and redissolved in water, yields a precipitate (L_3PO_4) with phosphate of soda. (Lithia is thus distinguished from the other alkalies. The slight solubility of its carbonate separates it from the alkaline earths.) 10 grains of the carbonate neutralised with sulphuric acid, and heated to redness, leave 14·86 grains of sulphate of lithia, which, when dissolved in water, yields no precipitate with oxalate of ammonia or lime water, (thus further distinguishing it from salts of the earthy metals).

Action. Uses.—It may be given in all cases when an alkali is required, and has an advantage over other alkaline carbonates in being less caustic. This, however, is more than counterbalanced by the insolubility of its phosphate, which renders it difficult for a salt of lithia to circulate in the blood to remote parts of the system. On account of the urate of lithia being more soluble than the other alkaline urates, its salts have been recommended in gouty cases, and to combat the tendency to lithic deposits in the urine. Uric acid calculi are said to have been dissolved by the repeated injections into the bladder of a warm solution of carbonate of lithia.

Dose.—10 to 30 grains. It may be given as below in carbonated water, in which it is more soluble than in simple water.

Pharmaceutical Uses.—In the preparation of the two following articles:—

Liquor Lithiæ Effervescens, *P.B.* *Lithia Water.*

Preparation.—Mix 10 grains of *carbonate of lithia* and 1 pint of *water* in a suitable apparatus, saturate it with carbonic acid gas under a pressure of seven atmospheres, and cork to prevent the escape of the compressed gas.

Characters and Tests.—Strong effervescence of carbonic acid when the cork of the containing vessel is removed. The liquid is clear and sparkling, and has an agreeable acidulous taste. Half a pint of it evaporated to dryness yields 5 grains of a white solid residue, answering to the tests for carbonate of lithia.

Dose.—5 to 10 fluid ounces.

LITHIÆ CITRAS, *P.B.*: $3LO,C_{12}H_5O_{11}$ or $L_3C_6H_5O_7$.

Citrate of Lithia.

This is a neutral or tribasic salt, like the other alkaline citrates.

Preparation.—Dissolve 90 grains of *citric acid* in crystals in 1 fluid ounce of warm *water*, and add 50 grains of *carbonate of lithia* in successive portions, applying heat until effervescence ceases, and a perfect solution is obtained. Evaporate by a steam or sand bath till water ceases to escape, and the residue is converted into a viscid liquid. This should be dried in an oven or air chamber at the temperature of about 240°, then rapidly pulverised, and enclosed in a stoppered bottle.

The citric acid and carbonate are used in equivalent proportions. Carbonic acid is expelled, and the soluble citrate, which does not easily crystallise, is obtained by drying at a low heat, and then kept from the air to prevent deliquescence.

Characters and Tests.—A white amorphous powder, deliquescent, and soluble in water without leaving any residue. Like the citrates generally, it blackens and evolves inflammable gases when heated to redness. Carbonate of lithia remains, which, neutralised by hydrochloric acid, yields, with rectified spirit, a solution which burns with a crimson flame (characteristic of lithia). Twenty grains of the salt burned in the air at a low red heat, leave 10·6 grains of white residue.

Action. Uses.—More convenient for use than the carbonate, on account of its solubility and pleasant saline taste. It is converted into a carbonate in the system by oxydation of the citric acid. (See Carbonate of Lithia.)

Dose.—10 to 30 grains.

BARIUM, Ba = 68·5 or Ba = 137.

Baryta was discovered by Gahn and Scheele about 1774. Davy discovered that it was the oxyde of a metal, which he named Barium —Βαρὺς, *heavy.*

Barium is a brilliant silver-white metal; heavy; sp. gr. above 2; when heated, burning with a red light in the air, and decomposing water, combining in both cases with oyygen, and forming an oxyde of barium, or the earth baryta.

Baryta. *Oxyde of Barium*, BaO = 76·5 or BaO = 153.

Baryta is a porous substance, of a greyish colour, devoid of odour, with a powerful caustic taste, alkaline reaction, corrodes animal substances; sp. gr. 4. It combines eagerly with water, evolves heat, and becomes a hydrate, which is not decomposed at a red heat; is with difficulty fused; insoluble in alcohol, but soluble in 20 parts of cold and 3 of boiling water, forming baryta water.

Tests.—It is detected by its alkaline reaction, and the heavy white precipitates which it forms with sulphuric acid or soluble sulphates; insoluble in nitric acid.

Action.—Baryta is acrid, caustic, and poisonous.

Use.—Baryta water is a delicate test for carbonic acid and the carbonates, producing with these, as with the soluble sulphates and phosphates, heavy white precipitates.

Carbonate of Baryta, $BaO,CO_2 = 98 \cdot 5$ or $BaCO_3 = 197$, contains in 100 parts Ba 77·7 + CO_3 22·3, was described in 1784 by Dr Withering, and named Witherite by Werner; it is rather common in Lancashire. It may be prepared in the form of a powder by precipitating the chloride by an alkaline carbonate. In its native state it occurs massive with a fibrous structure, or imperfectly crystallised in a globular form, or in hexagonal prisms, or pyramids.

Characters.—It is hard, of a white or greyish colour, without odour or taste, with a vitreous lustre, and subtransparent. Sp. gr. 4·29 to 4·3; nearly insoluble in water, unless there is excess of carbonic acid. The native carbonate is not decomposed by any heat, the artificial at a white heat in contact with carbonaceous matter.

Action. Uses.—Carbonate of baryta, though insoluble and tasteless, yet acts with considerable activity when introduced into the stomach.

Use.—It is employed in making the chloride.

Sulphate of Baryta, $BaO,SO_3 = 116 \cdot 5$ or $BaSO_4 = 233$, contains in 100 parts BaO, 65·66, and SO_3, 34·34, or Heavy Spar, is a more abundant mineral than the carbonate. The finest specimens have been obtained from Dufton in Cumberland. Dr Royle found it on the Himalayas, near the convalescent depôt at Landour. (See Illustr. Himal. Bot. p. xxxiii.).

Characters.—Heavy spar is massive or crystallised, of a foliaceous or lamellar structure; white-grey, or with a reddish hue; often translucent; heavy; sp. gr. 4·41 to 4·67; odourless and tasteless; insoluble in water. Its crystals are often bevelled tables or flat prisms of six sides, and may be divided into right rhombic prisms. Sulphate of baryta is insoluble in nitric acid. It is doubly refractive, decrepitates briskly before the blow-pipe, and is with difficulty fused, but eventually melts into a hard white enamel, which is not affected by acids. Sulphate of baryta, when heated with carbonaceous matter, is deoxydised, sulphide of barium being formed. From this the various salts of baryta may be made by operating with different acids, or it may be converted into carbonate by heating it to a red heat with three parts of carbonate of potash.

Action. Uses.—Inert. It is employed for making the other salts of baryta, being cheap, and usually pure.

Chloride of Barium, *P.B.:* $BaCl,2HO = 122$ or $BaCl_2 2H_2O = 244$, contains in 100 parts Ba, 65·86; Cl, 34·14. It is prepared from either the baric carbonate or sulphate, the latter being first heated with charcoal and the resulting sulphide saturated with hydrochloric acid.

Characters.—By evaporation of its solution it may be obtained in colourless rhombic plates, or flat tabular quadrangular prisms, with bevelled edges; sp. gr. 2·82; of an acrid and bitter, nauseous, disagreeable taste; efflorescent in very dry air. 100 parts of water at 60° dissolve about 40 parts; at the boiling point (222°) a saturated solution contains 78 per cent. of the salt; slightly soluble in rectified spirit, and in 400 parts of anhydrous alcohol, which will then burn with a greenish-yellow flame. (Strontian salts burn red.) At a moderate heat the crystals decrepitate and lose their water of crystallisation.

Tests.—Sulphuric acid and the sulphates throw down sulphate of baryta insoluble in nitric acid; it is also precipitated by the soluble phosphates, carbonates, and tartrates. Nitrate of silver gives a white precipitate (**AgCl**), which is soluble in ammonia, but insoluble in nitric acid. Impurities are less apt to occur when this salt is made with the sulphate than when made with the carbonate.

Action.—An irritant poison.

1. **Solution of Chloride of Barium,** *P.B.* = 1 part of the salt in 10 fluid ounces of water.

Uses.—Employed as a test for sulphuric acid and soluble sulphates, which precipitate heavy sulphate of baryta; insoluble in any acid or alkali. The nitrate may be used for the same purpose.

CALCIUM: Ca = 20 or **Ca** = 40.

Davy proved lime to be the oxyde of a metal, which has been called calcium, from calx. It is white, brilliant, decomposes water, and, when slightly heated, burns in the air, being converted into oxyde of calcium, or lime.

CALX, *P.B.*: *Lime.* CaO = 28 or **CaO** = 56.

Oxyde of Calcium. Caustic or Quicklime. F. *Chaux.* G. *Kalk.*

Contains in 100 parts **Ca** 71·43, **O** 28·57.

An alkaline earth with some impurities, obtained by calcining chalk or limestone, so as to expel carbonic acid.

Commercial lime is seldom pure enough for medicinal use. White Carrara marble, calcareous spar, chalk, shells, all yield good lime. The heat being sufficiently great, the carbonic acid is expelled, and about 56 per cent. of lime left in a caustic state, and tolerably pure; but if shells have been employed, it is mixed with a little phosphate of lime and oxyde of iron. It must be well protected from air, from which it absorbs both water and carbonic acid, and thus returns to its original condition. Lime is very infusible, and when heated in the oxyhydrogen flame, it is intensely luminous, forming the oxyhydrogen or limelight.

Characters and Tests.—In compact masses of a whitish colour, which readily absorb water, and which, when rather less than their weight of water is added, crack and fall to powder (hydrate of lime), with the development of much heat. The powder obtained by this process of slaking, when agitated with water gives, after filtration, a clear solution having the characters of Liquor calcis. The powder obtained by slaking dissolves without much residue and without effervescence (CO_2) in dilute hydrochloric acid; and if the solution thus formed be evaporated to dryness, and the residue redissolved in water, only a very scanty precipitate (alumina) forms on the addition of saccharated solution of lime.

CHARACTERS OF THE SALTS OF LIME.—Colourless; give no precipitate with ammonia, by which they are distinguished from salts of alumina and magnesia; a white precipitate ($CaCO_3$) with the carbonates of the alkali metals; no precipitate with solution of calcic sulphate, which precipitates salts both of baryta and strontia. Oxalate of ammonia produces, in extremely dilute neutral or alkaline solutions of lime salts, a white precipitate (calcic oxalate, $CaC_2O_4,2H_2O$) in microscopical octahedra, insoluble in acetic acid, but soluble in nitric or hydrochloric acid. Calcic salts give a glaucous tinge to flame, and in the spectrum a bright line in the orange, and a broad, less luminous band in the green.

Action.—Lime applied to moist surfaces is a powerful caustic. Burns of the conjunctiva from lime dust are not infrequent. They should be treated immediately with vinegar and water. When granulations are exuberant and unhealthy, a healthy action may be restored by dusting a little quicklime, or a mixture of quicklime and magnesia, upon the ulcer. In suppurating wounds involving the synovial membrane, such an application may prove very serviceable, by arresting the synovial discharge.

Pharmaceutical Uses.—In the preparation of alcohol, æther purus, chloral hydrate, and potassa cum calce.

CALCIS HYDRAS, *P.B.* *Slaked Lime.*

$CaO,HO = 37$ or $CaH_2O_2 = 74$.

Contains in 100 parts CaO 75·68, H_2O 24·32.

Hydrate of lime is formed whenever water is sprinkled upon caustic lime: it is immediately absorbed with a hissing noise, the lime splitting and crumbling into a dry, white, powdery hydrate with some impurities.

Preparation.—Place 2 pounds of *lime* in a metal pot, pour 1 pint of *water* upon it, and when vapour ceases to be disengaged, cover the pot, and set it aside to cool. When the temperature has fallen to that of the air, remove its contents, pass the powder through an iron-wire sieve, and put it into a well-stoppered bottle.

Slaked lime should be recently prepared.

Lime is thus capable of taking up 24·32 per cent. of its weight of water.

Pharmaceutical Uses.—In the preparation of Liquor calcis and Liquor calcis saccharatus, Calx chlorata, Æther, Chloroform.

1. **Liquor Calcis,** *P.B.* *Aqua Calcis.* *Lime Water.*

Contains 1 part of lime in about 700 of water.

Preparation.—Put 2 ounces of *slaked lime* into a stoppered bottle containing 1 gallon of *water*, and shake well for two or three minutes; set aside, that the undissolved lime may subside; after 12 hours, pour off the clear liquor, or decant with a syphon, when it is required. It should be preserved in a well-stoppered green glass bottle.

Dalton ascertained that, contrary to the usual law, lime is more soluble in cold than hot water; water at 60° dissolving $\frac{1}{778}$, and at 212°, only $\frac{1}{1270}$ of its weight. R. Phillips ascertained that water near the freezing point took up about $\frac{1}{7}$ more than water at 60°, and nearly double that of boiling water.

A pint of water at 32° dissolves 13·25 grains of lime.
„ „ 60° „ 11·6 „
„ „ 212° „ 6·7 „

Solution of lime requires to be kept in stoppered bottles, which are constantly filled, as it attracts carbonic acid from the air, which unites with the lime and forms a thin film of carbonate on the surface, and afterwards falls and accumulates as a white deposit. Its place should be supplied by some undissolved lime left in the bottle.

Characters and Tests.—Lime water is clear and transparent, without odour, but having a disagreeable astringent alkaline taste; changes vegetable blues to green, and forms an imperfect soap with oils; when evaporated under the vacuum of an air-pump, imperfect six-sided crystals (hydrate of lime) may be obtained. A precipitate of the carbonate may be formed by breathing into the solution through a glass tube. Ten ounces of lime water require for neutralisation at least 200 measures of the volumetric solution of oxalic acid, which corresponds to 5·6 grains of CaO or **CaO**.

Incompatibilities.—Acids and acidulous salts, alkaline carbonates, ammoniacal and metallic salts, borates, and astringent vegetable infusions.

Action.—Internally lime is an *antacid* and *astringent.* It probably diminishes secretion from the intestinal mucous membrane, and even from the stomach, in intervals of repose, by depositing a film of carbonate in the superficies of the membrane, thereby diminishing the secretion of the parts until the carbonate is redissolved by the formation of acid in the process of digestion. It probably passes through the capillaries as soluble chloride, to be again converted into carbonate in the blood, and held in solution by the free carbonic acid of that fluid. Lime, which has entered the blood, is eliminated by the kidneys, and frequently causes a deposit of oxalate. Since lime occurs in small quantities in most of the animal fluids and tissues, and, as phosphate and carbonate, constitutes nearly two-thirds of the weight of the bones, it must be regarded as a *restorative* whenever there is positive indication of any deficiency, as in rickets, mollities ossium. In excessive doses lime causes great thirst, obstinate constipation, and dry colicky pains.

Medicinal Uses.—In the diseases just mentioned the chloride would be a more appropriate form than the hydrate. In acid dyspepsia, especially when associated with diarrhœa and vomiting, lime water may be given freely with milk (1 part to 2 or 3 of milk). It is especially suitable in the gastric disturbances of infancy. As an antacid in ordinary dyspepsia and in pyrosis. As an astringent wash to ulcers and relaxed membranes, as in leucorrhœa, gleet, and otorrhœa; and an injection in dysentery, and against ascarides. Mixed with equal parts of olive or linseed oil, it forms a thick creamy emulsion (see Linimentum calcis), which is very soothing to burnt surfaces.

Dose.—2 to 8 fluid ounces three or four times a day in milk.

Pharmaceutical Uses.—In the preparation of Argenti oxydum, Linimentum calcis, Lotio hydrargyri flava, Lotio hydrargyri nigra.

2. **Liquor Calcis Saccharatus**, *P.B.* *Saccharated Solution of Lime*, 1 part of lime in about 50 of the solution.

Preparation.—Triturate together 1 ounce of *slacked lime* and 2 ounces of *sugar*. Transfer the powder to a bottle containing 1 pint of *water*, and having closed this with a cork, shake it occasionally for a few hours. Finally, separate the clear solution with a siphon, and keep it in a stoppered bottle.

Lime is far more soluble in a solution of sugar than in pure water. It forms with the sugar a distinct compound or salt, in which the sugar acts the part of an acid. This solution furnishes an elegant form for the administration of lime internally. It contains nearly 13 times as much lime as the Liquor calcis.

Tests.—Sp. gr. 1·052. 460·2 grains (1 fluid ounce) require for neutralisation 254 gr. measures of the volumetric solution of oxalic acid, which corresponds to 7·11 grains of lime. A much stronger solution may be obtained by the use of more sugar.

Action. Uses.—Those of Liquor calcis. As a reagent, it is in some cases a more convenient form than Liquor calcis.

Dose.—1 to 3 drachms, diluted with water or milk.

3. **Linimentum Calcis**, *P.B.* *Lime Liniment.*

This is an emulsion of calcareous soap and free oil.

Preparation.—Agitate briskly together equal parts of *lime water* and *olive oil*. Linseed oil may be used.

Both the oils are composed of oleic and margaric acids and glycerine: when mixed with lime water, oleates and margarate of lime (calcareous soap) are formed. It has long been employed as an application to burns and scalds, and as it is used for this purpose at the Carron Works it is often called Carron oil.

CARBONATE OF LIME: $CaOCO_2=50$ or $CaCO_3=100$.

Contains in 100 parts CaO 56, and CO 44.

F. *Carbonate de Chaux. Craie.* G. *Kohlensaurer Kalk.*

Calcic carbonate is one of the most widely diffused of minerals, and must have been one of the earliest employed in the arts and in medicine. It is found in a great variety of forms, forming mountain masses, either crystalline, as *Marble* and *Calc Spar*, or compact, as *Limestone*, in both stratified and unstratified rocks; and as *Chalk* in great beds, as the cretaceous series of rocks. It is also extensively diffused in particles throughout the soil, which by segregation become united into roundish or botryoidal masses. It is found in most springs, from which it is again deposited in a stalactical form. It is found in the ashes of most plants, the vegetable acids with which it was combined being converted into carbonic acid in the process of incineration. Carbonate of lime forms a constituent of the bones of Vertebrata, and a large part of the shells of testaceous Mollusca, Crustacea, and of Corals. Hence oyster-shells, crab's-claws—"crab's-eyes," as they are called, and corals, have all been employed in medicine, as was formerly the *lapis judaicus*, which is the spine of a fossil echinus. All consist of carbonate of lime, with some animal matter, and sometimes a little phosphate of lime intimately intermixed. Carbonate of lime is found crystallised in a variety of forms, derived from the rhombohedron, of which *Iceland-spar* (rhomb.) and *Aragonite* (six-sided prism) are the best examples. Many varieties, especially Iceland-spar, are transparent and remarkable for doubly refracting the rays of light. It has been artificially crystallised by Daniell in acute rhombic crystals, which contained 5 per cent. of water. Pure water dissolves calcic carbonate to the extent of about 2 grains in the gallon; but water charged with carbonic acid dissolves a much larger quantity, sometimes as much as 16 grains in the gallon, and on the escape of the gas it is precipitated in the form of anhydrous crystals. The deposition of calcic carbonate from hot water is well illustrated by the incrustation of the inner surface of the tea-kettle, the amount of which may be taken as a rough estimate of the amount of lime salt in the water of the locality. In the case of steam boilers, the lime forms a hard stratified deposit of marble upon the surface of the iron, to which it is so firmly adherent that it prevents the ready expansion and contraction of the metal, and sooner or later causes it to crack. This serious inconvenience may be prevented by the addition of a small quantity of sal-ammoniac to the water. Milk of lime may be added for the same purpose; it removes the lime by withdrawing the carbonic acid.

The presence of lime in water confers the quality of hardness, that is, a difficulty in forming a lather with soap. A solution of soap is employed to test the degree of hardness of different waters; it is added until a fine lather is produced in the mixture.

Heated in the air, carbonate of lime loses 44 per cent. of carbonic acid, lime being left; but if heated in close and strong vessels, no change takes place, and, on cooling, artificial marble is produced. (Sir J. Hall.) Bucholz fused it even without compression, when access of air was prevented. Carbonate of lime is readily decomposed by the acids with strong effervescence, forming soluble salts with nitric and hydrochloric acids, and insoluble ones with sulphuric acid. It may be formed artificially. (See Calcis carbonas precipitata.)

1. **Marmor Album,** *P.B.* *White Marble:* CaO,CO_2 or $CaCO_3$.

Hard white crystalline native carbonate of lime in masses. Pure white marble is intended; that of Carrara, commonly called statuary marble, is the purest variety. It is composed of minute crystals intersecting each other in every direction.

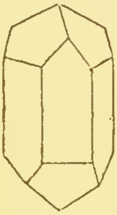

Fig. 35.

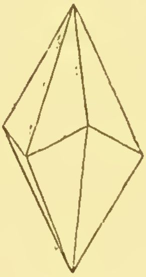

Fig. 36.

Tests.—Marble should dissolve with effervescence in dilute hydrochloric acid, without residue, proving the absence of silica and some other impurities. In this solution ammonia should (even after boiling) cause no precipitate, if neither magnesia (a constituent of some limestones), nor alumina, nor oxyde of iron (the most common impurities), are present. Neither ought it to give a deposit with a solution of sulphate of lime; if any precipitate appears, it must be sulphate of baryta or strontia. Aragonite usually contains a little strontia.

2. **Creta.** *P.B.* *Chalk.*

Native carbonate of lime, usually friable, sometimes hard. Sp. gr. 2·3.

Whiting is chalk ground in a mill, and the grosser impurities separated by sinking in water; while the pure chalk, being suspended, is allowed to settle, and made into small loaves. For medical use, it is similarly prepared (see Creta præparata).

Pharmaceutical Uses.—Both this and the former variety are used for the preparation of lime and the generation of carbonic acid.

3. **Creta Præparata,** *P.B. Prepared Chalk.*

Chalk freed from its impurities (soluble salts and siliceous particles) by elutriation, and afterwards dried in small masses, which are usually of a conical form.

Characters and Tests.—A white amorphous powder, effervescing (CO_2) with acids, and dissolving with only a slight residue (silica) in hydrochloric acid. This solution, when supersaturated with solution of ammonia, gives upon the addition of oxalate of ammonia a copious white precipitate ($CaC_2O_4,2HO$). The salt ($CaCl_2$) formed by dissolving the prepared chalk in hydrochloric acid, if rendered neutral by evaporation to dryness and redissolved in water, gives only a very scanty precipitate on the addition of saccharated solution of lime (absence of all but a trace of phosphates, oxyde of iron, and magnesia), or ammonia (trace of alumina).

Incompatibilities.—Mineral and vegetable acids which liberate carbonic acid (see carbonates, p. 98).

Action.—The physiological effects of chalk are those of lime (see Liquor calcis), but the action is more general, taking place throughout the whole of the intestinal track. Unless there be much acid in the stomach, the greater portion of the chalk passes unchanged into the intestines, and in its passage through them effectually deprives the secretions of any free acid they may contain. Thus, chalk may check intestinal digestion. The chloride or lactate of calcium thus formed, uniting in its passage into the blood with the phosphates, carbonates, and free carbonic acid of the animal fluids, would be decomposed, calcic carbonate, oxalate (if oxalic acid be present in the secretions), and phosphate being deposited in the mucous membrane, retarding and diminishing its secretions. Hence the "absorbent and desiccant" effects which are attributed to chalk. Its prolonged use is liable to be attended with the retention of undecomposed chalk, which may form concretions in the sacculi of the colon (see also Magnesia).

Medicinal Uses.—In diarrhœa to diminish the intestinal secretions, and also to correct abnormal acidity. In poisoning by strong mineral or vegetable acids, such as oxalic and carbolic. Externally it is beneficial in the form of powder in intertrigo, and cutaneous excoriations generally. In the form of ointment it is a good application to ulcers, diminishing secretion, and promoting, by this astringent action, cicatrisation.

Dose.—10 to 60 grains in one or other of the following combinations:—

Pharmaceutical Uses.—In the preparation of Hydrargyrum cum creta, Mistura creta, Pulvis cretæ aromaticus, Pulvis cretæ aromaticus cum opio.

4. **Calcis Carbonas Præcipitata,** *P.B.:* CaO,CO_2 or $CaCo_3$. *Precipitated Carbonate of Lime.*

This is a pure form of the carbonate, and is more finely divided than prepared chalk, although it is slightly crystalline.

Preparation.—Mix a solution of 5 ounces of *chloride of calcium* with an aqueous solution of 13 ounces of *carbonate of soda:*—$CaCl_2 + Na_2CO_3 = 2NaCl + CaCO_3$. The precipitated carbonate must be washed with boiling water until the washings cease to give a precipitate with nitrate of silver, and then dried at 212°.

Characters and Tests.—A white crystalline powder, insoluble in water, soluble in hydrochloric acid with effervescence (CO_2). The solution, when neutralised by ammonia, lets fall a copious white precipitate ($CaC_2O_4,2H_2O$, *calcic oxalate*), on the addition of oxalate of ammonia. With dilute nitric acid it gives a clear solution, which, if perfectly neutral and deprived of carbonic acid by boiling, is not precipitated by saccharated solution of lime added in excess (absence of phosphate of lime and magnesia), or by solution of nitrate of silver (absence of chloride).

Sulphate of lime has been used to adulterate this preparation. It would be easily detected by its insolubility both in hydrochloric and nitric acids.

Dose.—10 to 60 grains.

Pharmaceutical Use.—In the preparation of Trochisci bismuthi.

5. **Mistura Cretæ**, *P.B.* *Chalk Mixture.*

Preparation.—Triturate ¼ ounce each of *prepared chalk* and *gum acacia* in powder, with 7½ ounces of *cinnamon water*, then add ½ fluid ounce of *syrup.*

Dose.—1 to 2 fluid ounces.

6. **Pulvis Cretæ Aromaticus**, *P.B.* *Aromatic Powder of Chalk.*

This is intended to take the place of the Confectio aromatica of the P.L., than which it contains a little less chalk and a little more carminatives.

Preparation.—Mix thoroughly 11 ounces of *prepared chalk*, 4 ounces of *cinnamon bark* in powder, 3 ounces each of *nutmeg* and *saffron* in powder, 1½ ounce of powdered *cloves*, 1 ounce of powdered *cardamom seeds*, and 25 ounces of refined *sugar.* Pass through a fine sieve, and, finally, rub it lightly in a mortar. Keep it in a stoppered bottle.

Action and Uses.—Antacid and cordial. Useful in diarrhœa, and as an addition to soda, magnesia, or rhubarb powders.

7. **Pulvis Cretæ Aromaticus cum Opio**, *P.B.* *Aromatic Powder of Chalk and Opium.*

Composed of 1 grain of *powdered opium* and 40 grains of the *aromatic chalk powder* thoroughly mixed, and passed through a fine sieve.

Dose.—10 to 40 grains.

CALX CHLORATA, *P.B.* *Chlorinated Lime.*

Chloride of Lime. *Bleaching Powder.* F. *Chlorure de Chaux.*
G. *Chlor Kalk.*

This substance was first prepared by Messrs Tennant and Mackintosh in 1798. It is obtained by exposing slacked lime to the action of chlorine gas as long as the latter is absorbed. Heat is given out during the combination, and to prevent its rising above 100°, when calcic, chloride and chlorate would be formed (see p. 137), the chlorine is admitted gradually. In fig. 37 M is the tube by which the chlorine is admitted to a chamber, in which by means of suitable interruptions in the partitions the chlorine is made to circulate regularly over the surface of the lime exposed upon the partitions. By this means the lime absorbs about half its weight of chlorine.

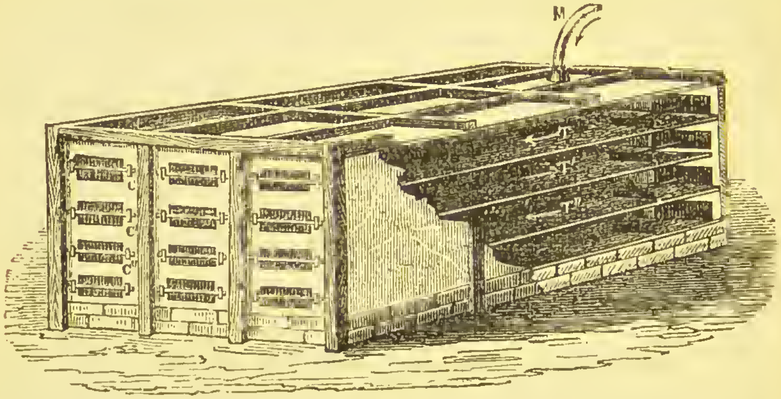

Fig. 37.

It is not possible thus to combine an equivalent of chlorine, so as to form chloride of lime ($\mathrm{CaOCl_2}$); and the preparation is generally regarded as a mixture or compound of hypochlorite and chloride of calcium, thus formed $2(\mathrm{Ca2HO})+2\mathrm{Cl}_2=\mathrm{CaCl}_2+\mathrm{Ca2ClO}+2\mathrm{H}_2\mathrm{O}$. A double salt it may be; but the chloride of calcium does not exist free, for freshly prepared chlorinated lime is not deliquescent, nor does it yield to alcohol more than a trace of calcic chloride.

This preparation usually contains more or less undecomposed lime. Fresenius found in 100 parts of a commercial sample 27·7 of hypochlorite, 25·5 of chloride, 23 of lime, and 24·8 of water. According to Ure, the strongest aqueous solution has a sp. gr. of 1·040.

Characters and Tests.—A dull white powder, with a feeble odour of chlorine, partially soluble in water. The solution evolves chlorine copiously upon the addition of oxalic acid, and deposits at the same time oxalate of lime. 10 grains mixed with 30 grains of iodide of potassium, and dissolved in 4 fluid ounces of water, produce, when acidulated with 2 fluid drachms of hydrochloric acid, a reddish solution, which requires for the discharge of its colours at least 850 gr. measures of the volumetric solution of hyposulphite of soda, corresponding to 30 per cent. of chlorine liberated by hydrochloric acid. (For the explanation of this test, see Liquor sodæ chloratæ, p. 156). A preparation which contains 30 per cent. of chlorine is not saturated with the gas, but may be regarded as properly prepared.

Exposed to the air, chlorinated lime absorbs carbonic acid, evolves chlorine, and is converted into a mixture of calcic carbonate and chloride, the latter making the powder deliquescent. When heated, chlorinated lime is decomposed with evolution of oxygen, into a mixture of chloride of calcium and chlorate of lime, thus:

$$9CaCl_2 + 9Ca2ClO = 12O + 17CaCl_2 + Ca2ClO_3.$$

Action.—This is identical, so far as the hypochlorous acid is concerned, with chlorinated soda. The bases also agree in having antacid properties, but the lime salt is astringent, owing to the decomposition of the chlorides, and the interstitial deposit of carbonate (see Liquor calcis).

Medicinal Uses.—The essential properties of chlorinated compounds are bleaching and deodorising. They are assumed to be also disinfectant. The last two properties are the only important ones in reference to therapeutics, and they depend on the evolution of chlorine. The slow liberation effected by the carbonic acid of the air is sufficient for the constant disinfection of the sick room. Plates containing the chlorinated lime, spread out and moistened with water, should be placed in each corner of the room. Hypochlorous acid is evolved, and coming in contact with organic matter rapidly oxydises it, with the simultaneous liberation of chlorine. For the purposes of rapid disinfection, the chlorinated lime should be placed in a deep dish or bowl, and moistened with dilute sulphuric acid. By this means the whole of the chlorine is set free, the sulphuric acid liberating hydrochloric acid by decomposition of the chloride of calcium at the same time that the hypochlorous acid is liberated from the hypochlorite, and by their mutual reaction these acids are reduced to chlorine and water: $HClO + HCl = H_2O + Cl_2$. Proof of the disinfecting power of chloride of lime is wanting, and it is unsafe to trust it to the exclusion of heat, carbolic acid, &c. It immediately decomposes, and renders innocuous sulphide of hydrogen, and a sponge or handkerchief saturated with the solution should be applied to the mouth and nostrils in a confined atmosphere containing this gas. For internal use the chlorinated soda is more suitable, but as a wash, injection, and gargle it may be used as the soda compound. In some cases, however, the astringent action of the lime preparation makes it the more suitable. It may be used as an astringent (60 grains to 1 ounce of lard).

Dose.—1 to 5 grains.

Pharmaceutical Uses.—In the preparation of chloroform, vapour chlori, and the following:—

1. **Liquor Calcis Chloratæ**, *P.B. Solution of Chlorinated Lime.*

Preparation.—Mix well 1 pound of *chlorinated lime* with 1 gallon of *water* by trituration in a large mortar, and having transferred the mixture to a stoppered bottle, let it be well shaken several times for the space of three hours. Pour out now the contents of the bottle on a calico filter, and let the solution which passes through be preserved in a stoppered bottle.

Characters and Tests.—The solution contains the hypochlorite of lime and chloride of calcium with a little caustic lime; it has a yellow tinge, an alkaline reaction, and bleaches strongly; sp. gr. 1·035. 60 grains mixed with 20 of iodide of potassium dissolved in 4 fluid ounces of water, when acidulated with 2 fluid drachms of hydrochloric acid gives a red (liberated iodine) solution, which requires for the discharge of its colour 500 gr. measures of the volumetric solution of hyposulphite of soda (see p. 161), corresponding to 13 grains of available chlorine in a fluid ounce. For the explanation of this reaction, see p. 156.

Uses.—That of solution of chlorinated soda, than which it is more astringent.

CALCII CHLORIDUM, *P.B.* *Chloride of Calcium.*

$CaCl = 55{\cdot}5$ or $CaCl_2 = 111$.

Calcium Chloride. Hydrochlorate or *Muriate of Lime.* E. *Chlorure de Calcium.* G. *Salzsaurer Kalk.*

Contains in 100 parts, Ca 36·03, Cl 63·97.

It is found in nature in sea water, and in many springs and mineral waters (see p. 43), sometimes associated with nitrate of potash, but usually with the chlorides of sodium and magnesium. It forms the residuum in the preparations of ammonia, viz., the liquor and carbonate; and in that of carbonic acid obtained by the action of hydrochloric acid on marble.

Preparation.—It may be formed by neutralising *hydrochloric acid* with *carbonate of lime*, adding a little solution of chlorinated lime and slaked lime to the solution, filtering, evaporating until it becomes solid, and finally drying the salt at about 400°.

Chloride of calcium so prepared is anhydrous, and being in a porous condition is used for the desiccation of gases, alcohol, æther, &c. If fused at a higher temperature a little chlorine is displaced by the oxygen of the air, and the resulting chloride has an alkaline reaction. Six-sided, striated prisms of the chloride, containing 6 equivs. of water of crystallisation, may be separated on evaporating the aqueous solution; and rectangular plates, containing 4 equivs. of alcohol, are deposited from an alcoholic solution. A saturated aqueous solution of the salt boils at 355°, and is employed where a temperature not exceeding this is required.

Characters and Tests.—In white agglutinated masses, dry, but very deliquescent, evolves no chlorine or hypochlorous acid, on the addition of hydrochloric acid, and is entirely soluble in twice its weight of water (it easily dissolves in its own weight of water at 60°), entirely soluble in alcohol. The aqueous solution is not precipitated by the addition of lime water (absence of magnesia, alumina, baryta, strontia, and iron).

Action and Uses.—See Liquor calcis and Creta preparata. In large doses it is an irritant poison. It is contained in some mineral waters (*e.g.* Harrogate), and has been recommended in scrofula.

Dose.—10 to 30 grains.

Pharmaceutical Uses.—It is used in the preparation of hydrochlorate of morphia; and of alcohol, æther, acetic æther, and chloroform, to remove the last traces of water. As a desiccant for gases, and as a test in the following solution:—

1. **Solution of Chloride of Calcium,** *P.B.* (1 part to 10 of water a test for oxalates, citrates, and tartrates.

CALCIS PHOSPHAS, *P.B.* *Phosphate of Lime.*

$3CaO,PO_5 = 155$ or $Ca_32PO_4 = 310$.

Tricalcic Phosphate. Bone Phosphate. F. *Phosphate de Chaux.* G. *Phosphorsaurer Kalk. Knochenerde.*

Phosphate of lime is the chief constituent of bones, teeth, and horns. Some animal excretions, as the tartar of the teeth, the phosphate of lime calculus, are formed of it. It exists also in wheat and almost all plants. It is obtained by burning bones or antlers (Cornu cervi ustum), and is employed for obtaining phosphorus and phosphate of soda (see pp. 61 and 161).

Preparation.—Digest 4 ounces of *bone ash* in 6 fluid ounces of *hydrochloric acid* diluted with a *pint of water* until it is dissolved. Filter, dilute the solution with another pint of water, and add 12 fluid ounces of solution of ammonia or sufficient to produce an alkaline reaction. Collect the precipitated phosphate of lime on a calico filter, and wash it with boiling water as long as the liquid which passes through occasions a precipitate (chloride of silver) when dropped into a solution of nitrate of silver acidulated with nitric acid. Dry the washed product at a temperature not exceeding 212°.

Bone earth contains nearly 10 per cent. of carbonate of lime, nearly 1 per cent. of fluoride of calcium, and 0·5 per cent. of phosphate of magnesia. The carbonic acid is expelled by the hydrochloric acid, and the insoluble fluoride is removed by filtration. A trace of magnesia remains.

Characters and Tests.—A light white amorphous powder insoluble in water, but soluble without effervescence (absence of carbonate, which is a constituent of bone ash) in dilute nitric acid; the solution continues clear when an excess of acetate of soda is added to it, but lets fall a white precipitate on the subsequent addition either of oxalate of ammonia or of perchloride of iron (these latter reagents precipitate oxalate of lime and phosphate of iron respectively, both of which are soluble in nitric acid, but insoluble in the acetic acid liberated, see acetates). 10 grains dissolve perfectly and without effervescence in diluted hydrochloric acid, and the solution yields with ammonia a white precipitate (tricalcic phosphate), insoluble in boiling solution of potash, and weighing 10 grains when washed and dried. (If alumina were present it would be dissolved by the caustic potash, and there would be a corresponding loss of weight in the residue.)

Action. Uses.—Operation uncertain. Proposed formerly to be used in Mollities ossium. It is a constituent of James's powder, and of Pulvis antimonialis.

Dose.—10 to 30 grains.

CALCIS HYPOPHOSPHIS, *P.B.* *Hypophosphite of Lime.*

$CaO,PO,2HO$ or $Ca2PH_2O_2$.

This salt crystallises in flattened prisms of a pearly lustre. It is soluble in 6 parts of water, insoluble in rectified spirit. It is made by boiling phosphorus with milk of lime till the odour of phosphuretted hydrogen is no longer perceived. 4 parts of fresh lime are used for 1 part of phosphorus. The water is decomposed. Its oxygen unites with part of the phosphorus, forming hypophosphorous acid (HPH_2O_2), which unites with lime remaining in solution. The hydrogen of the water unites with another portion of the phosphorus, forming phosphuretted hydrogen, a gas which takes fire spontaneously (see p. 66).

Action.—See hypophosphite of soda, p. 164. These salts are assumed to possess the stimulant action of uncombined phosphorus, but this cannot be so, since the tendency of these salts is to a higher state of oxydation, which they soon attain at the expense of the oxygen of the blood, and exert their action as phosphoric acid. The lime salt is an essential constituent of "Parishe's chemical food." It is employed in the preparation of the other hypophosphites.

Dose.—2 to 5 grains in syrup.

Pharmaceutical Use.—The preparation of Hypophosphite of soda.

MAGNESIUM: $Mg=12$ or $Mg=24$.

F. *Magnésium.* G. *Magnium.*

This metal is obtained by decomposing chloride of magnesium by potassium or sodium. It has the appearance of silver, and is hard and ductile; sp. gr. 1·74; volatile at about the same temperature as zinc; not acted on by water nor by air, except at a high temperature, when it becomes oxydised. It burns with an intense white light, depositing a cloud of magnesia. As a chloride, it forms a constituent of sea water; oxydised and combined with acids, it exists in sea water and in numerous mineral springs, and as a hydrate or native magnesia in a few places. It forms a portion of *Serpentine*, *Soapstone*, *Mica*, *Talc*, and many other minerals. It exists in most plants, as in the straw of wheat; also in small quantity in the animal system, especially in the urine and in some urinary calculi.

Characters of the Salts of Magnesium.—Colourless, a bitter taste, give a pink tinge with cobaltic nitrate in the blowpipe flame. No precipitate with the bicarbonates of the alkali metals till boiled; no precipitate with their carbonates in the presence of an ammonium salt, but an immediate precipitate of magnesic carbonate with the alkali carbonates alone. The fixed alkalies and lime water precipitate gelatinous magnesic hydrate insoluble in excess. Ammonia produces an incomplete precipitate soluble in ammonic chloride. Ammonic triphosphate gives an immediate granular-looking precipitate of stellate crystals of ammonio-magnesic phosphate (p. 66), soluble in acetic and mineral acids. No precipitate with oxalate of ammonia mixed with chloride of ammonium.

OXYDE OF MAGNESIUM: $MgO = 20$ or $\mathbf{MgO} = 40$.

The oxyde, or magnesia, may be obtained by burning the carbonate, or by adding potash or soda to a solution of one of its salts. The Pharmacopœia contains two following varieties of the compound:—

1. **Magnesia,** *P.B.*

Magnesic oxyde. Magnesia usta. Calcined Magnesia (Heavy).
Talc Earth. F. *Magnésie.* G. *Talkerde. Bittererde.*

Contains in 100 parts, **Mg** 60·28, and **O** 39·72.

Preparation.—Carbonate of magnesia is exposed to a low red heat in a loosely covered Hessian crucible until a small quantity, taken from the centre of the crucible and cooled, causes no effervescence when dropped into dilute sulphuric acid, *i.e.*, until the whole of the carbonic acid is driven off. It should be excluded from the air, otherwise it slowly absorbs both water and carbonic acid like lime.

Characters and Tests.—A white powder, insoluble in water, but readily in acids without effervescence (absence of carbonate). The solution in hydrochloric acid, when neutralised by a mixed solution of ammonia and chloride of ammonium, gives a copious precipitate (triple phosphate, $\mathbf{MgH_4NPO_46H_2O}$) with phosphate of soda. Dissolved in nitric acid, and neutralised by a mixture of ammonia and chloride of ammonium, it does not give any precipitate with oxalate of ammonia (absence of lime), or with chloride of barium (absence of sulphates).

Placed upon moistened turmeric paper magnesia turns it brown; this is due to the solution of a minute quantity: according to Fyfe, 51·42 parts of cold water, and 36·000 of hot water, dissolve one part. Sprinkled with water, a distinct hydrate containing 18 per cent. of water ($\mathbf{MgH_2O_2}$), is formed without the evolution of heat. It is slightly soluble in alcohol. The above preparation being made from the heavy carbonate, has a sp. gr. of 2·3, and is sometimes called heavy magnesia, to distinguish it from

2. Magnesia Levis, *P.B. Light Magnesia.*

It is obtained by the same process from the light carbonate of magnesia. It is so much more bulky that it occupies 3½ times as much space as a similar weight of the first variety. It is supposed to be somewhat more soluble in the juices of the stomach, and is used to make Pulvis rhei compositus.

Incompatibilities.—Acids, acidulous and metallic salts, and chloride of ammonium.

Actions and Uses.—Magnesia and its carbonate are very similar in their action on the system. They dissolve to some extent in the acid fluid of the stomach, and are then absorbed, an equivalent quantity of carbonic acid being liberated, which in some cases may form an objection to its use. Magnesia is antacid, and acts on the bowels as a laxative; but if given habitually as a purgative there is a danger of its concreting into a mass in the bowel. It is useful in cases of heartburn and acid dyspepsia, in diarrhœa, in gout, and in calculous complaints with acidity of urine. Alone, or with rhubarb, it is a suitable laxative for children. It is an appropriate antidote in poisoning by oxalic and the mineral acids.

Dose.—As an antacid, 10 to 30 grains; as a laxative, 20 to 40 grains; for infants, 2 to 10 grains.

MAGNESIÆ CARBONAS, *Carbonate of Magnesia.*

$3(MgO,CO_2)+MgO+5HO=191$ or $(MgCO_3)_3MgO,5H_2O=382$.

F. *Carbonate de Magnésie.* G. *Kolensaure Bittererde. Kolensaure Talkerde.*

Carbonate of magnesia was first called *Magnesia alba*, and *Comitissæ Palma pulvis*, and also *Pulvis albus Romanus*, from its medicinal use by Count de Palma at Rome. It occurs in some mineral waters, being held in solution by free carbonic acid. It is a very large constituent of dolomite or magnesian limestone ($MgCa2CO_3$).

Two varieties of so-called carbonate of magnesia are prescribed in the Pharmacopœia. They have the same composition, and differ only in bulk and sp. gr.—a difference due to the strength of the solutions from which the carbonate is precipitated, that from which the heavier variety is precipitated being four times stronger. Each is composed of a mixture of hydrated carbonate and hydrated oxyde. They are as follows:—

1. Magnesiæ Carbonas. *Carbonate,* or *Heavy Carbonate of Magnesia.*

Preparation.—Dissolve 10 ounces of *sulphate of magnesia* and 12 ounces of *carbonate of soda,* each in a pint of *water;* mix the two solutions, and evaporate the whole to dryness on a sand bath. Digest the residue for half an hour with 2 pints of water; collect the insoluble matter on a calico filter, wash it repeatedly with distilled water until the washing ceases to give a precipitate with chloride of barium. Finally, dry at a temperature not exceeding 212°. In double decompositions of this kind we have usually a simple interchange of acids and bases, and in this case should have expected sulphate of soda and carbonate of magnesia only; but the attraction for basic water is in respect of 1 equiv. of the magnesia sufficiently strong to liberate the carbonic acid, thus: $4MgSO_4 + 4Na_2CO_3 + 5H_2O = 3MgCO_3,MgH_2O_2,4H_2O + 4Na_2SO_4 + CO_2$. The sulphate of soda is separated by solution in water, and so completely washed out of the magnesian precipitate that chloride of barium fails to indicate a trace of sulphuric acid. An equiv. of carbonic acid escapes, and a mixture of 3 atoms of hydrated carbonate with 1 of hydrated magnesia remains.

Characters and Tests.—A white granular powder, which dissolves with effervescence in the dilute mineral acids, yielding solutions which, when treated with chloride of ammonium, are not disturbed by the addition of an excess of solution of ammonia (absence of lime and alumina), but yield a copious crystalline precipitate (triple phosphate) with phosphate of soda. With excess of hydrochloric acid it forms a clear solution, in which chloride of barium causes no precipitate (absence of sulphuric acid); another portion, supersaturated with ammonia, gives no precipitate with oxalic acid or sulphuretted hydrogen (proving the absence of lime, alumina, and metals generally). 50 grains calcined at a red heat are reduced to 22 of magnesic oxyde, both water and carbonic acid being dissipated. According to the above formula only 20·94 grains should remain, since 382 : 160 : : 50 : 20·94.

2. Magnesiæ Carbonas Levis, *P.B.* *Light Carbonate of Magnesia.*

The same ingredients, and in the same proportions as for carbonate of magnesia, are used in this preparation, but the solutions are four times more diluted. The mixture is boiled for 15 minutes, and the magnesic precipitate is then separated and washed repeatedly with boiling water until the washings cease to give a precipitate with chloride of barium.

Characters and Tests.—A very light powder, composed of microscopic granules and slender prisms. The other characters and tests are same as those of carbonate of magnesia.

Carbonate of magnesia of both kinds is a pure white, impalpable powder. It is sometimes pressed, when in the moist state, into the form of cubes. Considerable differences are observed in the density of carbonate of magnesia, according to the mode of preparation. It is nearly insoluble in water, and, like lime, is more soluble in cold than in warm water, and the solubility is greatly increased by the presence of carbonic acid (see the following preparation).

Impurities.—Carbonate of magnesia is not liable to adulteration. If chalk or gypsum were used, the first would be readily detected by precipitation of the neutral solution with oxalate of ammonia; and the second by its insolubility in hydrochloric acid and slight solubility in water, the solution precipitating chloride of barium.

Incompatibilities.—Acids, acidulous and metallic salts, chloride of ammonium, and lime water.

Actions. Uses.—Antacid, laxative. Differs from magnesia in the evolution of carbonic acid, which renders it unsuitable in flatulency and in poisoning by the corrosive acids. But in other cases, where the presence of carbonic acid is desirable, as in irritability of the stomach, the action of the carbonate is milder and more efficacious.

Dose.—5 to 20 grains as an antacid; 15 to 60 grains as a laxative, with water, milk, &c.; 14 grs. = 20 of citric acid.

Pharmaceutical Uses.—In the preparation of Trochisci bismuthi (2½ grains nearly in each), Liquor magnesia citratis, and the following:—

3. Liquor Magnesiæ Carbonatis, *P.B.* *Solution of Carbonate* (or *Bicarbonate*) *of Magnesia. Fluid Magnesia.*

Preparation.—Add to a boiling solution of 2 ounces of *sulphate of magnesia* in ½ a pint of water, a solution of 2½ ounces of *carbonate of soda* in ½ a pint of water, and boil the mixture until carbonic acid ceases to be evolved. Collect and wash the precipitated carbonate until the washing ceases to give a precipitate with chloride of barium. Mix it with a pint of water, saturate it with washed *carbonic acid*, and let it remain in contact with an excess of the gas under pressure for twenty-four hours. Then filter from any undissolved carbonate of magnesia; again pass carbonic acid into the solution, and bottle it. This solution contains about 13 grains of carbonate of magnesia in a fluid ounce. It resembles the well-known solutions of Dinneford and Murray. It probably contains the bicarbonate of magnesia.

Characters and Tests.—Effervesces slightly, or not at all, when the containing vessel is first opened. The liquid is clear, and free from any bitter taste; a fluid ounce of it evaporated to dryness yields a white solid residue, which after calcination weighs not less than 5 grains (magnesia). This residue is insoluble in water, and answers to the test for magnesia. Allowed to evaporate spontaneously, long transparent rectangular crystals are deposited from the solution.

A substitute may be prepared by pouring a bottle of ordinary soda water (carbonic acid water) over 60 grains of the light carbonate of magnesia; or a mixture of crystallised sulphate of magnesia and crystallised carbonate of soda in powder in equivalent proportions (123 parts of the former to 148 of the latter).

Uses.—An agreeable form of the carbonate for exhibition in dyspepsia and the lithic acid diathesis.

Dose.—1 to 2 fluid ounces.

MAGNESIÆ CITRAS. *Citrate of Magnesia.*

$3MgO,C_{12}H_5O_{11}4HO$ or $3Mg2C_6H_5O_7,4H_2O$.

This salt is formed when a solution of citric acid is neutralised with magnesia or magnesic carbonate. It is obtained as a white amorphous and nearly tasteless powder, on evaporating the solution to dryness. It is sparingly soluble in water, but is readily soluble in water acidulated with an excess of citric acid, when the acid or magnesic dihydric citrate (see below) is formed.

Robiquet prepares this soluble salt by mixing *carbonate of magnesia* 63 parts, with *citric acid* 100 parts, dissolved in a small quantity of water, taking care to avoid any elevation of temperature. The product is dried in a stove, and forms a light, spongy, brittle mass, which should be readily soluble in water.

Action and Use.—It is a mild saline, and may be given in effervescence by mixing 14 parts of dried citric acid with 10 of carbonate of magnesia, and adding to water when required. A preparation has been sold as *Effervescing Citrate of Magnesia*, which contains no magnesia at all, but is analogous to the Sodæ Citro-tartaras effervescens of the Pharmacopœia.

LIQUOR MAGNESIÆ CITRATIS, *P.B.* *Solution of Citrate of Magnesia.* F. *Limonade purgative au Citrate de Magnésie.*

A solution of acid or magnesic dihydric citrate, $MgH_2C_6H_5O_7,H_2O$, in a slight excess of citric acid and carbonic acid water.

Preparation.—Dissolve 200 grains of *citric acid* in 20 ounces of water, and having added 100 grains of *carbonate of magnesia*, stir until it is dissolved. Filter the solution into a soda water bottle, add ½ fluid ounce of *syrup of lemons;* then introduce 40 grains of *bicarbonate of potash* in crystals, and immediately close the bottle with a cork, which should be secured with string or wire. Afterwards shake the bottle until the bicarbonate of potash is dissolved.

Action and Use.—An agreeable and mild aperient draught suitable for children and delicate persons, and especially where there is irritability of the stomach.

Dose.—5 to 10 fluid ounces.

MAGNESIÆ SULPHAS, *P.B.* *Sulphate of Magnesia.*

$MgO,SO_3+7HO=60+63$, or $MgSO_4,7H_2O=120+126$.

Epsom Salts. *Vitriolated Magnesia.* F. *Sulphate de Magnésie.* G. *Schwefelsaure Bittererde.*

Contains in 100 parts, crystals, MgO 16·36, SO_3 32·47, H_2O 51·27; dry, MgO 33·50, SO_3 66·50.

This salt was discovered in 1675 by Dr Grew, in a spring at Epsom. It is found in many countries effloresced on the soil, and on rocks which contain a sulphate or sulphide. It is called *hair salt* and *bitter salt.* It exists in many mineral springs and in sea water in the proportion of 15 to 20 grains in a pint. Its true nature was fully explained by Dr Black in 1755.

Preparation.—There are three great sources of this, the most important salt of magnesia,—viz., 1. Bittern; 2. Magnesite; and 3. Dolomite. Bittern (sea water left after the crystallisation of common salt, see p. 84) contains sulphate of magnesia and chloride of magnesium. The former crystallises on further evaporation of the fluid, and the whole of the magnesia may be separated as sulphate, by the addition of sulphuric acid to the mother liquor and crystallisation. The sulphate is prepared from magnesite (native carbonate of magnesia) by merely saturating it with sulphuric acid and crystallising the solution. Dolomite, or magnesian limestone ($MgCa2CO_3$), has now become the chief source of sulphate of magnesia. It may be prepared by simply saturating dilute sulphuric acid with the powdered stone and separating the soluble magnesic sulphate from the insoluble calcic sulphate; or the stone may be roasted to expel carbonic acid, slaked, and largely washed with water, to remove part of the lime; then mixed with sulphuric acid, and the mixed calcic and magnesic sulphates separated by crystallisation. Sometimes it is more convenient to remove the lime from the mixed hydrates by a carefully adjusted quantity of hydrochloric acid, and to convert the magnesia thus isolated into sulphate by digesting it with sulphate of iron. The magnesia displaces the sulphuric acid from the salt, and the iron separates as hydrated protoxyde: $FeSO_4+H_2MgO_2=MgSO_4+H_2FeO_2$: the latter rapidly changes to the rusty peroxyde, and is filtered away.

Characters and Tests.—In minute colourless and transparent right rhombic prisms (fig. 38), possessing a bitter taste, slightly efflorescent in dry air, soluble in their own weight of water at 60°, and in less than three-fourths of their weight at 212°. Insoluble in alcohol. Heated moderately, the salt loses its water of crystallisation, and at a higher temperature fuses into a white enamel. If the heat be intense and prolonged, some of the acid is dissipated. An aqueous solution of the salt gives copious white precipitates with chloride of barium, and with a mixed solution of ammonia, chloride of ammonium and phosphate of soda (indicating respectively the presence of sulphuric acid and magnesia,—the precipitate of triple phosphate is granular, and composed of microscopical crystals). The aqueous solution is not precipitated at ordinary temperatures by oxalate of ammonia (showing the absence of lime), nor should it give a brown precipitate (peroxyde of iron or manganese) with chlorinated lime or soda. The precipitate (carbonate and hydrate of magnesia) given by carbonate of soda in a boiling solution of 100 grains of the salt, should, when well-washed, dried, and heated to redness, weigh 16·28 grains (of magnesia).

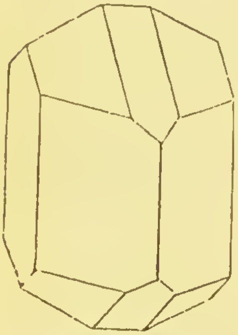
Fig. 38.

Sulphate of magnesia is isomorphous with sulphate of zinc, and the crystals of the two salts are undistinguishable by the eye. The taste readily distinguishes between them. Sulphide of ammonium is an equally decisive mode of discrimination.

Sulphate of magnesia is usually pure. If it show a tendency to deliquescence, a little chloride of magnesia is present, and this may be detected by nitrate of silver, or the evolution of hydrochloric acid on moistening the crystals with sulphuric acid and gently warming. The presence of sulphate of soda, in the absence of other impurities, is indicated by a falling short in the weight of magnesia, obtained, as above, by ignition of the precipitate by carbonate of soda.

Incompatibilities.—Potash, soda, ammonia, and other carbonates; lime water, and salts of lime, barium, and lead. See salts of magnesia, p. 183. The bicarbonates of potash and soda and sesquicarbonate of ammonia do not produce precipitates unless carbonic acid is driven off by heating the mixed solutions.

Action.—This salt is readily absorbed into the blood in the upper part of the alimentary canal, and rejected from the lower portions of it with a considerable quantity of water. The direct action of the sulphate in the blood is to diminish the cohesive tendency of the red corpuscles, and to retard coagulation. In escaping from the blood-vessels, it is probable that it carries out a portion of the fibrin of the blood with it. The action of sulphate of magnesia is therefore decidedly antiplethoric and antiphlogistic.

Medicinal Uses.—As a mild and efficacious purgative, it is useful in all cases when more than a laxative effect is required. It is particularly suitable in plethora and febrile disorders. It should be taken fasting (an hour or two before breakfast), well diluted with water, whereby the nauseous bitter taste of the concentrated solution is converted into a not very disagreeable saline flavour. The addition of an ounce or two of the acid infusion of roses, or 30 minims of dilute sulphuric acid, increases its purgative effect. It is an appropriate antidote in poisoning by acetate of lead or the salts of baryta.

Dose.—¼ to 1 ounce, with an aromatic carminative.

Pharmaceutical Uses.—Employed in the Mistura sennæ composita (1 ounce in 5 fluid ounces), and the following two preparations:—

1. Enema Magnesiæ Sulphatis, *P.B.* *Enema of Sulphate of Magnesia.*

Composed of 1 ounce of *the salt* dissolved in 15 fluid ounces of *mucilage of starch*, and then mixed with 1 fluid ounce of *olive oil.*

Action and Use.—A cooling demulcent purge in constipation, or in coma, &c., where there is a difficulty in giving an aperient by the mouth.

2. Solution of Ammonio-sulphate of Magnesia, *P.B.*

$MgSO_4,H_4NSO_4,6H_2O$.

Preparation.—Dissolve 1 ounce of *sulphate of magnesia* and ½ ounce of *chloride of ammonium* in 8 fluid ounces of *water*, and to the mixture add ½ fluid ounce of *solution of ammonia* and enough water to measure in all 10 fluid ounces. Filter.

Uses.—A test for phosphoric acid and the phosphates with which it yields a crystalline precipitate of triple phosphate, $MgH_4NPO_4, 6H_2O$ (see p. 66).

CHLORIDE OF MAGNESIUM: $MgCl = 47{\cdot}5$ or $MgCl_2 = 95$.

Is a plentiful constituent of several fashionable springs (see pp. 43 to 46) and of sea water. It is a stimulant purgative.

ALUMINIUM: $Al = 13{\cdot}75$ or $Al = 27{\cdot}5$.

This metal was discovered by Davy, and carefully examined by Wöhler in 1828. It has lately been produced in considerable quantity by M. Deville of Paris. It is a white malleable metal resembling zinc in colour and hardness, of sp. gr. 2·5. After fusion it crystallises on cooling in regular octohedra. Nitric acid has but little action upon it, even at a boiling temperature. Solutions of the alkalies, on the contrary, attack it vehemently, and convert it into alumina, with the evolution of hydrogen. Its lightness and insusceptibility of oxydation admirably suit it for weights representing fractions of a grain.

CHARACTERS OF THE SALTS OF ALUMINIUM.—A sweet astringent taste, and acid reaction. They assume a pale azure blue when moistened with nitrate of cobalt and gently ignited. A white precipitate (hydrate of alumina) with sulphide of ammonium and evolution of sulphuretted hydrogen. A bulky gelatinous precipitate (hydrate of alumina) with ammonia and the carbonates of the alkalies, nearly insoluble in excess, but soluble in caustic potash, and reprecipitated by chloride of ammonium. Sulphate of potash and slight excess of sulphuric acid yield, with salts of aluminium, regular octohedra of alum.

Alumina ($Al_2O_3 = 103$) the only oxyde, is isomorphous with sesquioxyde of iron. It may be obtained by treating solution of alum with an excess of ammonia, when a copious precipitate of white gelatinous hydrate of alumina falls down; or by prolonged ignition of ammonia alum (see Alumen).

Alumina is devoid of smell or taste, but adheres to the tongue; is very infusible, has a great affinity for water, attracting it from the atmosphere to the extent of one-third of its own weight. When mixed with water it is distinguished by its plasticity; hence, in its impure state, it has from the earliest times been employed in pottery. It has also a strong affinity for various organic substances, and especially colouring matters; salts, therefore, which contain it, have been long employed in dyeing and calico-printing.

Alumina fuses before the oxyhydrogen blowpipe, forming a transparent colourless mass like corundum. In its crystalline state tinged with a trace of metallic oxyde (chrome or iron), it is familiar as the ruby and sapphire. The six-sided prisms of corundum are also nearly pure alumina. Emery is a less pure form. All are remarkable for their hardness, which is but little inferior to that of the diamond. Clay, which is the basis of artificial building materials, and of earthenware and porcelain, is a combination of alumina and silica.

Utensils required to stand a high temperature are made of a pure infusible siliceous clay, nearly colourless. Oxyde of iron gives a brown colour, and renders the clay fusible. The composition of the fictile utensils employed in chemical and pharmaceutical operations is represented in the following table:—

	Porcelain.				Wedgwood ware.	Lambeth stoneware.	Hessian crucibles.
	English.	Berlin.	Sèvres.	Meissen.			
Silica, . . .	40·60	71·34	58·0	57·7	66·49	74·00	71
Alumina, .	24·15	23·76	34·5	36·0	26·00	22·04	25
Oxyde of iron,	...	1·74	...	0·8	6·12	2·00	4
Lime, . . .	14·22	0·57	4·5	0·3	1·04	0·60	...
Alkali, . .	5·28	2·00	3·0	5·2	0-20	1·06	...
Magnesia, .	0·43	0·20	...	trace.	0·15	0·17	...
Bone earth and oxyde of iron,	15·32	...	...	...	...	...	...
	100·00	99·61	100·0	100·0	100·00	99·87	100

Earthenware forming the table service and kitchen utensils are made of inferior and more fusible kinds of clay. As it is not fused in the process of firing, it is porous and readily cracks on the sudden application of heat or cold. It is rendered impervious to liquids by a varnish of hard glaze, which almost always contains lead. Earthenware utensils are therefore unsuitable for use in the laboratory.

ALUMEN, *P.B.* *Alum.*

$NH_4OSO_3,Al_2O_3,3SO_3+24HO$ or $H_4NAl(SO_4)_2,12H_2O=237{\cdot}5+216$.

Sulphate of Ammonia and Alumina. Ammonia Alum. Argilla Vitriolata. F. *Alun.* G. *Alaun.*

The names Alumen of the Romans (Pliny xxxv. c. 15) and στυπτηρία of the Greeks (Diosc. v. c. 122) were no doubt applied to several salts of the nature of vitriols, and among them to the natural sulphate of iron. The Arabs also included a variety of salts under the generic name of *Shib.* Alum, however, was probably not unknown, as Pliny (xxxv. c. 15, § 52) says, "Quoniam inficiendis claro colore lanis, candidum liquidumque utilissimum est." The Egyptians and Hindoos have from the very early ages been acquainted with the arts of dyeing and of calico-printing. The Hindoos employ potash alum for clarifying muddy water. It may be obtained in every Indian bazaar, and is manufactured in Cutch. The first alum works known to Europeans were established at Roccha, formerly called Edessa, in Syria (whence the commercial name of *roch alum*); then near Smyrna, whence the Genoese and others supplied Europe. About the middle of the fifteenth century they were established in Italy, afterwards in Germany, Spain, and at Whitby in England in the reign of Elizabeth. (Aikin, *Dict.* i. p. 43.)

There are several kinds of alum. The best known is *potash alum* ($KAl2SO_4,12H_2O$), a sesquisulphate of alumina combined with sulphate of potash. *Soda alum* and *ammonia alum* are formed by replacing the equivalent of potash with one of soda or ammonia. *Iron alum* results when the alumina is replaced by peroxyde of iron. These alums have all the same crystalline form, and resemble each other in astringency and medicinal properties. As ammonia alum has the same value in the arts as potash alum, and as it is far more easily and cheaply made by means of the sulphate of ammonia obtained from gas liquor, it has to a great extent taken the place of the old potash alum in commerce. Ammonia alum is now adopted in the B.P., instead of potash alum previously alone recognised.

Preparation.—Alum is prepared in England by the two following processes:—1. Finely powdered clay or shale is gently roasted and then mixed with half its weight of sulphuric acid, and heated for three or four days. The mass is next lixiviated, and the solution of aluminic sulphate (Al_23SO_4) freed from iron by the addition of potassic or sodic ferrocyanide. As long as a blue precipitate forms (see p. 100), the clear liquor is then decanted, evaporated, and crystallised as aluminic sulphate, or mixed with a due proportion of sulphate of potash, soda, or ammonia, and crystallised as alum. 2. By freely exposing to the air for a time, or roasting aluminous schist—a bituminous shale containing a large proportion of finely divided iron pyrites (FeS_2) disseminated through it. By either process the sulphide of iron is converted, by the absorption of oxygen, into sulphate and sulphuric acid, thus:—$2FeS_2+6O=2FeS+2SO_4$, and $FeS+4O=FeSO_4$. The sulphuric acid combines as it is formed with the alumina. After a time the mass is lixiviated, and sulphates of alumina and iron separated from each other by crystallisation, and the aluminic sulphate converted into alum by the addition of an alkaline sulphate, or where, as in the Whitby works, the sulphate of alumina much exceeds that of the sulphate of iron, chloride of potassium is added instead of sulphate of potash, whereby this salt and the very soluble chloride of iron are formed, thus:—$2KCl+FeSO_4=FeCl_2+K_2SO_4$. The sulphate of potash combines with the aluminic sulphate to form alum, which is readily crystallised from the ferrous chloride.

Characters and Tests.—In colourless transparent crystalline masses, exhibiting the faces of the regular octahedron (fig. 39), and having an acid, sweetish, astringent taste, soluble in about 18 parts of water at 60°, and $\frac{3}{4}$ of its weight at 212°. At 92° it melts in the water of crystallisation, and if the heat be increased, the whole of this water is expelled. Above 400°, ammonia and sulphuric acid escape, and the residue is composed of a mixture of alumina and sulphate of alumina. By prolonged ignition at an intense heat, the remaining sulphuric acid is expelled, and pure alumina remains. An aqueous solution of the salt gives, with caustic potash or soda, a white precipitate (hydrate of alumina), soluble in excess of the reagent (showing absence of lime), and the mixture evolves ammonia, especially when heated (see p. 121). Chloride of barium gives an immediate precipitate (sulphate of baryta). The aqueous solution does not acquire a blue colour by the addition of yellow or red prussiate of potash (showing absence of both proto- and persalt of iron). The potash alum of commerce, called roch alum, is in small crystalline fragments, with less transparency, and of a reddish hue.

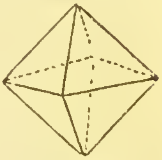

Fig. 39.

Incompatibilities.—Alkalies and their carbonates, lime water and salts of lime, tartrate of potash, phosphates, salts of lead, and mercury.

Action. Uses.—Given internally it undergoes absorption, and passing into the blood it diminishes all the secretions, and checks hæmorrhage at distant parts. Alum applied in the form of powder is slightly caustic, producing desiccation, resulting in molecular disintegration of the surface to which it is applied. As a styptic it is useful in epistaxis and uterine hæmorrhage. A saturated solution may be injected into the bleeding cavity; and if the bleeding in the latter case be otherwise uncontrollable, a sponge saturated with a strong solution may be placed as a plug in the upper part of the vagina. It is a useful styptic to check the too free bleeding of leech bites. As an *astringent* in fluxes from the alimentary canal (as in enteritis and dysentery), it is inferior to sulphate of copper, but may be employed where the use of that salt is objectionable. In leucorrhœa, gonorrhœa, purulent ophthalmia, and chronic catarrh, it is a most valuable remedy. In the latter disease inhalation of the powder is used. A mixture of equal parts of very finely powdered alum, calcined magnesia, and powdered gum acacia are placed in a wooden box, containing a large wheel with broad plate-like spokes like a water wheel, and furnished with a multiplying handle. The dust being raised by the rotation of the wheel, the patient inhales it by means of a wide tube communicating with the interior of the box.

Dose.—10 to 20 grains internally. As a gargle, lotion, or injection, a saturated aqueous solution. A very powerful astringent lotion is formed by a combination of sulphate of zinc and alum, an ounce of each being dissolved in 3 pints of boiling water. As a collyrium, from 2 to 10 grains to 1 fluid ounce.

1. Alumen exsiccatum, *P.B.* *Dried Alum.* *Alumen ustum.*

Alum, when thoroughly heated, forms a light, spongy, opaque mass, losing its water of crystallisation, but retaining its other properties.

Preparation.—Heat *alum* in a porcelain capsule till it liquefies, raise and continue the heat, not allowing it to exceed 400° till aqueous vapour ceases to be disengaged, and the salt has lost 47 per cent. of its weight. Reduce the residue to powder, and preserve it in a well-stoppered bottle. Care must be taken that the heat is not too powerful, or the ammonia and a portion of the sulphuric acid will be drawn off.

Action. Uses.—Escharotic. Chiefly used to destroy exuberant granulations, or "proud flesh;" for this purpose a little of the powder is dusted on the surface of the ulcer.

CERIUM: $Ce=46$ or $Ce=92$.

This metal was discovered by Berzelius in 1803 in a Swedish mineral called *cerite* or *heavy stone.* It is intimately associated with two other rare metals, lanthanum and didymium, and also with iron. The latter is separated by solution of the mineral in hydrochloric acid, and precipitation by benzoate of ammonia. On the addition of excess of ammonia oxyde of cerium falls. The metal may be separated by treating the chloride with potassium. It is difficult to separate it from traces of the two metals above mentioned. Thus prepared it is a greyish metallic powder, which when heated in the air burns, and is converted into oxyde.

OXYDES OF CERIUM.—These are two—protoxyde, CeO, and sesquioxyde, Ce_2O_3. Both should be white, but the former is often coloured yellow or brownish yellow by oxyde of didymium.

CHARACTERS OF SALTS OF CERIUM.—The soluble salts have a sweet astringent taste; the alkalies and their carbonates give a yellowish-white precipitate, insoluble in excess; phosphate of soda precipitates phosphate of cerium, soluble in nitric acid. Oxalic acid and oxalate of ammonia each give a precipitate of oxalate of cerium, also soluble in nitric acid. A strong solution of either sulphate of potash or soda precipitates a characteristic double sulphate of potash, or soda and cerium. Yellow prussiate of potash gives a white precipitate. Neither sulphuretted hydrogen nor infusion of galls give any precipitate.

CERII OXALAS, *P.B.* *Oxalate of Cerium.*

$2CeO,C_4O_6+6HO$ or $CeC_2O_4,3H_2O$.

Preparation.—Add solution of *oxalate of ammonia* to a neutral solution of the chloride. Collect the precipitated *oxalate of cerium* on a filter, and wash with water until the filtrate no longer gives any turbidity with solution of nitrate of silver (absence of chloride).

Characters and Tests.—A white granular powder, insoluble in water, decomposed at a dull red heat into a reddish brown powder (sesquioxyde), which dissolves completely, and without effervescence, in boiling hydrochloric acid, and the resulting solution gives with solution of sulphate of potash a white crystalline precipitate (ceroso-potassic sulphate). If the salt be boiled with solution of potash and filtered, the filtrate is not affected by solution of chloride of ammonium (absence of lead or silver); but when supersaturated with acetic acid, it gives with chloride of calcium a white precipitate (oxalate of lime), soluble in hydrochloric acid. 10 grains when incinerated lose 5·2 grains in weight.

Action and Uses.—The salt resembles bismuth in its action. It was introduced by Simpson as a remedy for the vomiting of pregnancy and morbid uterine irritation.

Dose.—1 to 2 grains.

MANGANESIUM, Mn = 27·5 or **Mn** = 55.

F. *Manganese.* G. *Mangan.*

This metal was discovered by Gahn in 1774. It is hard, brittle, and of a greyish white colour, emitting a peculiar odour when handled or in a moist atmosphere. Sp. gr. 8. When pure, it oxydises readily in the air, requiring to be kept under naphtha, and is quickly dissolved by dilute sulphuric acid. It forms numerous combinations with oxygen, but the black, or peroxyde, is alone officinal.

MANGANESII OXYDUM NIGRUM, *P.B.* *Black Oxyde of Manganese.*

MnO_2, 43·5 or $\mathbf{MnO_2} = 87$.

Manganesii Binoxydum. F. *Oxyde noir de Manganese.* G. *Manganhyperoxyd.*

Contains in 100 parts, **Mn** 63·22, **O** 36·78.

The binoxyde of manganese, called also peroxyde, is found most abundantly in nature. Pyrolusite, psilomelane, varvicite, and wad of mineralogists, are all forms of binoxyde. It is variable in appearance, sometimes crystallised in needles, often in compact masses.

Characters and Tests.—A heavy (sp. gr. 4·9) black powder, free from taste and odour, insoluble in water, but dissolving almost entirely in hydrochloric acid with evolution of chlorine (see p. 87), and gives off oxygen when ignited.

Binoxyde of manganese is seldom pure, usually containing more or less of oxyde of iron, carbonates of lime and of iron, sulphate of baryta, and clayey matter. Its purity is judged of by the quantity of oxygen or chlorine evolved, or more conveniently by the combined reaction of the black oxyde, oxalic and sulphuric acids, sulphate of manganese is formed, and the liberated oxygen converts the oxalic acid into water and carbonic acid, thus: $MnO_2+H_2SO_4+H_2C_2O_4=MnSO_4+2H_2O+2CO_2$; an equiv. of the binoxyde giving its own weight, *i.e.*, 2 equivs. of carbonic anhydride. This reaction illustrates the oxydising property of the binoxyde.

Pharmaceutical Uses.—1. As a source of oxygen:—heated to redness it gives off one-third of its oxygen, and becomes converted into red oxyde: $3MnO_2=O_2+Mn_3O_4$. 2. As an oxydising agent, heated with sulphuric acid it parts with half of its oxygen, water and sulphate of manganese remaining, thus: $2MnO_2+2H_2SO_4=O_2+2MnSO_4+2H_2O$. This is illustrated by the conversion of oxalic acid into carbonic acid (see above). 3. To liberate chlorine from hydrochloric acid (see p. 78). 4. By the aid of sulphuric acid to liberate chlorine, bromine, and iodine from the chlorides, bromides, and iodides respectively (see pp. 75, 88). 5. In the preparation of permanganate of potash (see p. 144).

Various soluble preparations of manganese have been recently introduced as medicines. In small doses they are alterative and tonic; in large doses, purgative. Ure and Hannon state that they have a remarkable power of increasing the secretion of bile. The sulphate and acetate are soluble in water. They may be given as alteratives in skin diseases and gout, in doses of 5 to 10 grains; or to the amount of 1 to 2 drachms as cathartics, being especially suitable in torpid states of the liver. They are not astringent.

IRON: $Fe=28$ or $Fe=56$.

Mars of the Alchymists. F. *Fer.* G. *Eisen.*

Iron is found native, when it is supposed to be of meteoric origin; extensively in combination with oxygen, sulphur, carbonic, and sulphuric acids; all these compounds being in a more or less pure state. It also exists in the vegetable and animal juices, and is an essential constituent of the blood.

The metal is extracted from magnetic oxyde and specular iron ore, in Sweden, Elba, and India, by heating them with charcoal, when the carbon combining with the oxygen, the iron is set free and melted.

In order to separate it from the carbonate, iron pyrites, clay iron ore, red and brown hæmatite, and spathose iron, each of these ores is first roasted, and then exposed to a fierce heat in contact with charcoal, coke or small coal, and a flux of either lime or clay, according as the ore is argillaceous or calcareous. The carbonic acid and sulphur of the two first named compounds are expelled, and the oxygen of the latter is removed by the carbon as carbonic oxyde, which being inflammable is utilised in roasting the ore. The earthy matters become vitrified, and form a slag at the surface; while the heavy particles of iron, falling down, run out by a hole at the bottom into moulds, and form *pig* or *cast iron.* This is still impure from the presence of charcoal, sulphur, and portions of silicon and aluminium.

It is again twice fused in the refining and puddling furnaces, and exposed to the influence of a current of air, at a high temperature, when the whole of the charcoal and sulphur are burnt out, and the other impurities form a slag. In Bessemer's process liquid crude iron is decarbonised by forcing air through it by machinery. The metal is taken out, beaten or pressed, and then drawn into bars which form the *malleable* or *wrought iron* of commerce.

Iron is whitish grey, hard, but malleable, and, though more ductile than many, exceeds all the metals in tenacity. It may be highly polished, and takes a sharp edge. Sp. gr. 7·8. It is remarkable for its power of attracting and being attracted by the magnet, and of becoming, as do also some of its compounds, magnetic. When heated it becomes soft; at a white heat two pieces may be inseparably joined together, or *welded.* It melts at a bright white heat, or 1587° of Daniell's pyrometer, but is not volatile. If exposed to the air when heated, or when moist, it absorbs oxygen, and its surface becomes covered with a coat of rust ($Fe_2O_3H_2O$). It burns in oxygen gas with vivid scintillations. It slowly takes the oxygen of water, hydrogen gas escaping. Chlorine, bromine, and iodine combine directly and rapidly with iron, so that if it be placed even in a vessel of water with either of these elements, union is speedily effected, and a solution of the chloride, bromide, or iodide is formed.

It combines with oxygen to form the following compounds:—1. *Protoxyde* (FeO), the base of the green salts of iron; 2. The sesquioxyde or *peroxyde* (Fe_2O_3), the base of the yellow or red salts; 3. The black or *magnetic oxyde*, Fe_3O_4 or (FeO,Fe_2O_3); and 4. Ferric acid, a weak metallic acid. Iron slowly decomposes water, undergoing oxydation while the hydrogen is slowly escaping. It dissolves with the evolution of hydrogen in dilute sulphuric or hydrochloric acid, a protosalt of iron being formed. The addition of an alkali to these solutions precipitates a greenish white hydrated protoxyde of iron ($FeOH_2O$), which on exposure to the air rapidly absorbs more oxygen, and is converted into the hydrated red peroxyde ($Fe_2O_3H_2O$), as occurs in the preparation of several of the compounds of iron.

CHARACTERS OF THE SALTS OF IRON.—1. *Salts of the protoxyde*, a pale green colour. *Alkalies* give a greenish grey precipitate (hydrated protoxyde, FeO,H_2O), which rapidly absorbs oxygen, and changes to a foxy-red (peroxyde, $Fe_2O_3H_2O$). *Ammonia* redissolves a portion of the precipitate it causes, and the solution is completely effected by the addition of *chloride of ammonium;* by the absorption of oxygen peroxyde is precipitated. No precipitate in acid solutions by *sulphuretted hydrogen.* A black precipitate of hydrated sulphide ($FeSH_2O$) with sulphide of ammonium. A pale blue precipitate, becoming darker on exposure, with *yellow prussiate of potash.* A bright blue ($Fe_3Fdcy_2H_2O$) with *red prussiate of potash.* Chlorine, bromine, and nitric acid, or chlorate of potash at a boiling temperature, convert the proto- into persalts.

2. *Salts of Peroxyde.*—Reddish-brown in solution. A foxy-red precipitate with the alkalies, insoluble in excess. *Sulphuretted hydrogen* converts them into protosalts, with separation of sulphuric acid and sulphur, thus: $2(Fe_23SO_4) + 2H_2S = 4FeSO_4 + 2H_2SO_4 + S_2$. *Sulphide of ammonium* precipitates black sesquisulphide in the hydrated form ($Fe_2S_3H_2O$). *Yellow prussiate of potash* gives Prussian blue (Fe_4Fcy_3,H_2O). *Red prussiate of potash* causes only a greenish-brown hue, without any precipitate. *Sulphocyanide of potassium* gives a deep blood-red colour; *tincture of galls*, in neutral solutions, an inky precipitate.

Action and Uses of the Compounds of Iron.—The preparations of iron, grouped together as chalybeates, are commonly said to be tonics, but they are not of use in cases of simple debility, except when attended with paleness or anæmia. In anæmia there is a deficiency of the red capsules of the blood, which contain iron. When a chalybeate medicine is administered, it is partly or entirely absorbed, according to its solubility, and its passage into the blood is commonly succeeded by an increase in the amount of the red corpuscles. Iron is the only direct remedy which can be employed in anæmia and its kindred disorders.

The persalts (of which the perchloride may be taken as the type) are astringent, and somewhat corrosive. The protosalts (of which the sulphate is the type) are less astringent, and more readily absorbed. Among the milder preparations are reduced iron, carbonate of iron, and the phosphate of iron, insoluble in water, but dissolved in the stomach to some extent; also the ammonio-citrate and the potassio-tartrate, which are soluble, and very efficient.

The iodide of iron combines the powers of its two constituents; it may be given with great advantage in small doses in scrofula combined with anæmia.

1. **Ferrum,** *P.B.* *Iron.*

Wrought iron in the form of wire or nails, free from oxyde. Wire (and nails are made from wire) is the purest and most malleable form of iron, and is therefore selected for medicinal use.

Pharmaceutical Uses.—In the preparation of Ferri iodidum, Ferri sulphas, Ferri sulphas granulata, Liquor ferri perchloridi fortior, Liquor ferri pernitratis, Mistura ferri aromatica, Pilula ferri iodidi, Syrupus ferri iodidi, and Vinum ferri.

2. **Ferrum Redactum,** *P.B.* *Reduced Iron.* *Ferri Pulvis.*

Metallic iron, with a variable amount of magnetic oxyde.

Preparation.—Pass perfectly *dry hydrogen* through *hydrated peroxyde of iron* enclosed in the centre of a gun barrel between plugs of *asbestos*, and heated to a strong red heat until the hydrogen is no longer absorbed. Then remove the fire and allow the furnace to cool, and continue the stream of hydrogen until the gun barrel and its contents are of the temperature of the air. Withdraw the reduced iron, and enclose it in a dry-stoppered bottle. $Fe_2O_3 + 3H_2 = Fe_2 + 3H_2O$, the steam thus formed by the union of the hydrogen and the oxygen of the oxyde, condenses in the water into which the exit tube of the gun barrel dips. But some magnetic oxyde is also formed; thus, $3Fe_2O_3 + H_2 = H_2O + 2Fe_3O_4$.

Characters and Tests.—A fine greyish black powder, strongly attracted by the magnet, and exhibiting metallic streaks when rubbed with firm pressure in a mortar. It dissolves in hydrochloric acid, with the evolution of hydrogen, and the solution gives a light blue precipitate with the yellow prussiate of potash (absence of peroxyde). 10 grains added to an aqueous solution of 50 grains of iodine and 50 grains of iodide of potassium, and digested in a small flask at a gentle heat, leave not more than 5 grains (magnetic oxyde:—the iodine is dissolved by the iodide of potassium, and this solution of free iodine readily combines with the finely divided iron, and dissolves it out of the magnetic oxyde which remains unaltered), undissolved, which should be entirely soluble in hydrochloric acid (absence of silica and mechanical impurities). The preparation should therefore contain at least half its weight of finely divided metallic iron. It is said that the magnetic oxyde of iron is often substituted for this iron powder, the *Fer réduit* of Quevenne. It is certain that it often contains as much as 18 to 20 per cent. of oxygen, which it probably absorbs from the atmosphere. As a subsulphate is frequently formed in the precipitation of the peroxyde, the reduced iron may also contain some sulphide of iron. This interferes with its utility as a medicine, H_2S being evolved in the stomach, and causing disagreeable eructations.

Action. Uses.—Iron in a pure state or in filings is nearly inert; but in this finely separated form it is easily dissolved in the stomach; it acts as a tonic. It is soluble to some extent in cod-liver oil.

Dose.—1 to 10 grains in electuary, with honey or treacle, in pills with extract of liquorice, or in the following form:—

3. **Trochisci Ferri Redacti,** *P.B. Reduced Iron Lozenges.*

Preparation.—Mix together 720 grains of *reduced iron*, 25 ounces of powdered *sugar*, and 1 ounce of *gum acacia;* add 2 fluid ounces of *mucilage of gum acacia*, and 1 ounce of *water*, and form a proper mass. Divide into 720 lozenges, and dry with a moderate heat.

Each lozenge contains 1 grain of reduced iron.

Dose.—1 to 6 lozenges.

FERRI PEROXYDUM HYDRATUM. *Hydrated Peroxyde of Iron.*

$Fe_2O_3,HO = 80 + 9$ or $Fe_2O_3,H_2O = 160 + 18$.

Ferric Oxyde. Sesquioxyde. Red Oxyde. Colcothar. Crocus Martis. Rouge. F. *Peroxyde de Fer.* G. *Rothes Eisenoxyd.*

Contains in 100 parts, Fe 59·89, O 25·67, and H_2O 14·44.

This oxyde of iron is abundant in nature as a constituent of many red soils; and crystallised in the form of rhombs and octohedrons, with highly-polished facets as *Specular Iron*, or *Iron Glance of Elba.* In a compact state with impurities, as *Red*

Hæmatite or *Bloodstone*. *Brown Hæmatite* and *Göthite* are native hydrates of the peroxyde. These give a reddish-brown streak on paper, and with borax form a green or yellow glass; are considerably magnetic, but do not, like magnetic iron, attract iron filings.

Preparation.—Dry moist *peroxyde of iron* at a temperature not exceeding 212°, until it ceases to lose weight; then reduce to a fine powder.

Characters and Tests.—A reddish brown powder, destitute of taste, and not magnetic. It dissolves completely, though slowly, with the aid of heat in hydrochloric acid diluted with half its volume of water; and the solution (perchloride) gives a copious precipitate (Prussian blue) with the yellow, but none (absence of protosalt) with the red prussiate of potash. Heated to dull redness in a test tube, it gives off moisture (and is converted into the anhydrous form).

When recently prepared, the hydrated peroxyde dissolves easily in acids, forming the persalts of iron, which have a strongly acid reaction, are usually deliquescent, and do not crystallise under ordinary circumstances. If dried at 212°, the hydrated peroxyde retains only 10·11 per cent. of water, and this is slowly but completely driven off at 608°. At dull redness it suffers molecular change, contracting in bulk and dissolving in all acids, excepting the hydrochloric, with difficulty.

Action.—Chalybeate tonic and emmenagogue.

Dose.—In neuralgia, 5 to 30 grains, or even ½ an ounce, two or three times a day. Care should be taken in giving these large doses that the oxyde does not accumulate in the colon, as insoluble powders are apt to do.

1. **Emplastrum Ferri,** *P.B. Chalybeate Plaster. Emplastrum Roborans.*

Preparation.—Add 1 ounce of *hydrated peroxyde of iron* in fine powder to 2 ounces of *Burgundy pitch*, and 8 ounces of *lead plaster*, previously melted, and stir the mixture constantly till it stiffens on cooling.

Uses.—The efficacy of the oxyde of iron is doubtful. The plaster is stimulant; spread on stout leather it gives mechanical support to relaxed muscles, and affords warmth and protection to painful or delicate parts.

2. **Ferri Peroxydum Humidum,** *PB.. Moist Peroxyde of Iron.*

Hydrated peroxyde of iron, with about 86 per cent. of uncombined water.

Preparation.—Mix 4 fluid ounces of solution of *persulphate of iron* with a pint of *water*, and add it gradually to 33 fluid ounces of *solution of soda*, stirring constantly and briskly. After standing for two hours, with occasional stirring, filter and wash the precipitate until the water used for the purpose ceases to give a precipitate with chloride of barium (showing that the sulphate of soda has been completely washed out). Enclose the precipitate, without drying it, in a well-closed vessel, so that it may be preserved moist. It should be recently made for use, otherwise it becomes granular and crystalline, from the formation of an allotropic hydrate.

When the solutions are mixed, as above directed, the bases simply interchange the acid and water: $Fe_2 3SO_4 + 6NaHO = F_2O_3 3H_2O + 3Na_2SO_4$. By mixing the solutions in a reverse order to that given above, a large quantity of oxysulphate is precipitated, resembling the peroxyde in appearance, but differing essentially from it in chemical characters.

Characters and Tests.—A soft moist pasty mass, of a reddish brown colour. Dissolves readily in diluted hydrochloric acid without the aid of heat, and the solution gives a copious blue precipitate (Prussian blue) with the yellow, but not with the red prussiate of potash (absence of peroxyde, see salts of iron, p. 197). A little, dried at 212° until it ceases to lose weight, gives off moisture when heated to dull redness in a test tube (proving the presence of hydrate), and not a mere admixture of the peroxyde with water.

Action and Use.—The hydrated peroxyde combines so readily with arsenious acid, that when prepared according to the following formula, and added in the proportion of 12 parts to 1 of arsenious acid in solution, and well shaken, the filtered liquor which previously contained the arsenic afterwards displays no traces of its presence, an insoluble arseniate of the protoxyde of iron having been formed. (Graham.)

Dr A. Taylor has shown that the peroxyde exerts little or no chemical effect upon arsenious acid in the form of powder; but this does not invalidate the antidotal properties of the peroxyde; for there can be no doubt that the arsenic is reduced to solution before it can exert corrosive action; and if an excess of the peroxyde be present, it may exercise an immediate protective action both chemically and mechanically.

Dose.—$\frac{1}{2}$ to 1 ounce, made potable with water, every 10 minutes.

FERRI OXYDUM MAGNETICUM, *P.B.* *Magnetic Oxyde of Iron.*

$Fe_3O_4 = 116$ or $Fe_3O_4 = 232$.

Black Oxyde. *Æthiops Martialis.* F. *Oxyde de Fer noir.* G. *Schwarzes Eisen Oxydul.* *Eisen Mohr.*

Magnetic oxyde of iron, combined with about 20 per cent. of water of hydration, and containing some peroxyde of iron. This mineral forms the *loadstone*—the magnetism of which is acquired from the inductive influence of the earth. It occurs in beds in the primitive rocks, and furnishes the purest kind of iron. It is black, has a metallic lustre, sp. gr. 5, and crystallises in cubes, octohedra (fig. 40) or rhombic dodecahedra. It is the principal constituent of the scales of the smith's forge, and of the oxyde formed by burning iron in oxygen. A definite hydrate ($F_3O_4 4H_2O$) may be obtained by the following process:—

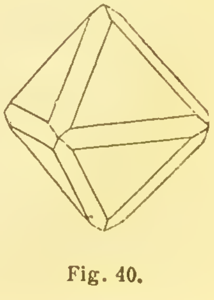

Fig. 40.

Preparation.—Add to a solution of 2 ounces of *sulphate of iron* in 2 pints of *water* 5½ fluid ounces of *solution of persulphate of iron*, and mix this with 4 pints of *solution of soda*, stirring them well together. Boil the mixture, let it stand, with occasional stirring, for two hours, then collect the precipitate on a calico filter and wash it with water until chloride of barium ceases to give a precipitate with the filtrate (indicating that the sulphate of soda has been washed out). Lastly, dry the precipitate at a temperature not exceeding 120° (otherwise it becomes dense, compact, and less soluble in acids). In this process the soda simultaneously precipitates hydrated protoxyde from the protosalt ($FeSO_4 + 2NaHO = Na_2SO_4 + Fe_2OH_2O$), and hydrated peroxyde from the persalt (see Ferri peroxydum humidum), and these, as soon as they are separated, combine to form the magnetic oxyde, thus: $FeOH_2O + Fe_2O_33H_2O = Fe_3O_4,4H_2O$.

This preparation shows no tendency, in either dry or moist air, to undergo any change.

Characters and Tests.—Brownish black; tasteless; strongly attracted by the magnet; heat expels water from it. It dissolves without effervescence in hydrochloric acid diluted with half its bulk of water (forming a solution of the perchloride and protochloride of iron). This solution gives blue precipitates with both red and yellow prussiates of potash (showing presence of both proto- and persalt of iron). When a small quantity is heated in a dry test tube by a flame, a deposit of moisture (showing presence of hydrate) forms on the cool part of the tube. 20 grains dissolved in hydrochloric acid continue to give a blue precipitate with the red prussiate of potash until 230 measures of the volumetric solution of bichromate of potash have been added, showing the presence of 3·86 grains of iron in the condition of protosalt (the addition of the above quantity of bichromate is just sufficient to convert it into the state of persalt, see p. 146, line 16, where for 83 read 230, and for 8·3, 23).

Action. Uses.—Chalybeate tonic. The more ready solubility of this preparation in the gastric acid gives it an advantage over the peroxyde.

Dose.—5 to 20 grains twice or thrice a day.

FERRI IODIDUM, *P.B.* *Iodide of Iron.*

$FeI,4HO = 155 + 36$ or $FeI_2,4H_2O = 310 + 72$.

Ferrous Iodide. F. *Iodure de Fer.* G. *Eisen Iodür.*

Contains in 100 parts Fe 14·66, I 66·5, and H_2O 18·84.

The iodide of the Pharmacopœia contains about 18 per cent. of water of crystallisation, and a little oxyde of iron.

Preparation.—Put 3 ounces of *iodine*, 1½ ounce of fine *iron wire*, and 12 ounces of *water* into a flask, heat gently for ten minutes, then raise the heat and boil until the froth becomes white. Filter rapidly through moistened calico into a dish of polished iron, and boil down the solution until a drop removed on the end of an iron rod solidifies on cooling, then pour it out upon a porcelain dish, and, as soon as it has solidified, break it into fragments and preserve in a well-stoppered bottle.

The iodine and iron combine directly, and with the development of heat, and, if artificial heat be applied at first, the action becomes violent. The soluble iodide disappears in the water as fast as it is formed, and dissolves free iodine, by which the union with the iron is moderated and retarded. On boiling, however, with the excess of iron the whole of the free iodine is rapidly removed, and the solution has only a faint green tinge. Evaporated in vacuo, crystals containing 4 equivs. of water of crystallisation ($FeI_2,4H_2O$) are formed. Prepared as above the fused salt also contains this proportion of water, unless the exposure to heat be prolonged, when the whole of the water is driven off. Prolonged exposure to the air, however, is objectionable, oxygen being absorbed, the iron separates as peroxyde, and the iodine is set free. To avoid this, both the solution and the fused salt are prepared as rapidly and with as little exposure as possible, iron being always present in excess; a little oxyde is formed notwithstanding.

Characters and Tests.—Flat crystalline plates or fragments, green with a tinge of brown, inodorous, deliquescent, almost entirely soluble in water (a very small quantity of peroxyde remaining), forming a slightly green solution, which gradually deposits a rust-coloured sediment (peroxyde of iron from the absorption of oxygen), and acquires a red colour (from the separation of iodine). Its solution gives a copious blue precipitate with the red prussiate of potash (showing the presence of a protosalt of iron). Mixed with mucilage of starch, it acquires a blue colour (iodide of starch) on the addition of a minute quantity of solution of chlorine (indicating the presence of an iodide). It is soluble in alcohol.

Many suggestions have been made for preserving this compound from decomposition, but none have succeeded. The following method will, I believe, be found effectual:—Let the fused salt be cast into small plates or cylinders about half an inch thick, when cold weigh them in ounce or four ounce lots, and dip each fragment in melted stearin, using the pure distilled variety of which the best candles are made. The varnish of stearin cools so rapidly that the iodide may be bottled at once. When required for use the stearin may be readily scraped off.

If preserved at all in solution, a piece of iron wire should be constantly immersed in it, as suggested by Mr Squire. By this means the iodine is preserved in combination, but a precipitate of peroxyde of iron accumulates.

Incompatibilities.—Chlorine, acids, alkalies, and their carbonates, lime water, vegetable astringents (tannic acid).

Action. Uses.—Combines a chalybeate action with the alterative properties of iodine. Particularly useful in the anæmia of scrofulous children.

Dose.—1 to 5 grains in the form of pill, dissolved in cod-liver oil, or as the following:—

1. **Syrupus Ferri Iodidi**, *P.B. Syrup of Iodide of Iron.*

Preparation.—Prepare a syrup by dissolving 28 ounces of *sugar* in 10 ounces of *water* with the aid of heat. Digest 2 ounces of *iodine* and 1 ounce fine *iron wire* in a flask, at a gentle heat, with 3 ounces of *water*, till the froth becomes white; then filter the liquid while still hot into the syrup, and mix. The product should weigh 2 lbs. 11 oz., and should have the specific gravity of 1·385. It contains 4·3 grains of iodide of iron in 1 fluid drachm.

Direct combination of the iodine with the iron takes place as in the previous preparation. It is complete when the froth becomes white.

Sugar prevents the protoxyde of iron from passing to the state of peroxyde, as in the Ferri carbonas saccharata, and thus has been found to preserve the iodide of iron. When freshly prepared this syrup has a very faint greenish tinge, after a time it becomes colourless, and then slowly assumes a light straw colour from the liberation of a trace of iodine, and at the same time has a slight deposit of peroxyde of iron. The sugar retards this change, and the solution may be preserved for a long time unchanged, if it be excluded from light and air. When in use a coil of iron wire may be kept immersed in the syrup. The patient should be supplied with the undiluted syrup, as decomposition is accelerated by mixture with water.

Dose.—½ to 1 fluid drachm.

2. **Pilula Ferri Iodidi**, *B.P. Pill of Iodide of Iron.*

Preparation.—A strong solution of iodide of iron is formed by direct combination, as in the preceding preparations, but without the application of heat, and this is made into a mass with sugar and liquorice root. Agitate 40 grains of fine *iron wire* with 80 grains of *iodine* and 50 minims of *water* in a strong stoppered ounce bottle until the froth becomes white. Pour the fluid upon 70 grains of *powdered sugar*, add gradually 140 grains of *liquorice root* powder, and make a mass.

The mass will weigh 357 grs., and contain nearly 100 gr. of iodide of iron; 3½ grs. of the pill will therefore contain 1 gr. of iodide of iron.

Dose.—4 to 10 grains. These pills should only be used when freshly made.

Bromide of Iron, $FeBr=108$ or $FeBr_2=216$, is prepared in precisely the same way as the iodide, substituting bromine for iodine. Bromide of iron acts as an energetic tonic. It is also recommended in dysmenorrhœa, and to relieve a congested state of the uterine organs.

CHLORIDES OF IRON.

Iron forms with chlorine two compounds, protochloride or ferrous chloride, $FeCl$ or $FeCl_2$, and the sesquichloride, perchloride or ferric chloride, Fe_2Cl_3 or Fe_2Cl_6.

The **Protochloride** is obtained as anhydrous volatile scales by passing hydrochloric acid over ignited metallic iron; or by dissolving iron in hydrochloric acid, from which it is obtained by evaporation in green crystals, containing 4 equivs. of water ($FeCl_2,4H_2O$). It is very soluble in water, but the solution rapidly changes by absorption of oxygen into the perchloride, and if heated in the air, chlorine is evolved and ferric oxyde precipitated. A *teinture de protochlorure de fer* of the French is much used on the Continent.

The **Perchloride.**—The anhydrous variety is prepared by the same process as the anhydrous protochloride; it has the form of brown deliquescent scales, which hiss when thrown into water, and form a red solution. The hydrated variety is formed by passing chlorine through a solution of the chloride; by dissolving the hydrated peroxyde of iron in hydrochloric acid; or by the peroxydation of the protosalt, as in the next preparation. It separates from a concentrated solution in large red deliquescent crystals, containing 6 equivs. of water of crystallisation ($Fe_2Cl_6,6H_2O$). It forms double salts with the chlorides of ammonium, sodium, or potassium. The first of these, *ammonio-chloride of iron*, is still used in medicine (see p. 207). By solution of the black oxyde of iron in hydrochloric acid, a mixture of the proto- and perchloride is obtained.

1. **Liquor Ferri Perchloridi Fortior**, *B.P.* *Stronger Solution of Perchloride of Iron.*

Sesquichloride or *Muriate of Iron.* F. *Perchlorure de Fer.*
G. *Eisenchlorid.*

Preparation.—Dilute 8 fluid ounces of *hydrochloric acid* with 8 fluid ounces of *water*, and dissolve in it 2 ounces of *iron wire* with a gentle heat. Add to the filtered solution 9 fluid drachms of *nitric acid* and 4 fluid ounces of *hydrochloric acid*, and heat briskly until, on a sudden evolution of red fumes, the liquid becomes of an orange-brown colour. Evaporate in a water bath to 10 fluid ounces.

A protochloride of iron is first formed, with the escape of hydrogen (see p. 91). In the second part of the process the nitric acid oxydises the hydrogen of the hydrochloric acid, forming water, and sets free another portion of chlorine, which unites with the protochloride—$6FeCl_2 + 6HCl + 2HNO_3 = 4H_2O + 2NO + 3Fe_2Cl_6$. Any excess of nitric acid is expelled in the process of evaporation, and it is well to facilitate this by brisk boiling. The solution, as made by the above process, contains about 6 ounces of the perchloride of iron in 10 fluid ounces, or 31·7 grs. in a fluid drachm.

Characters and Tests.—Orange-brown, with a strong styptic taste, miscible in all proportions with water and spirit. Diluted with water it is precipitated white ($AgCl$) with nitrate of silver, and blue (Prussian blue, $Fe_4 3FeCy_6 H_2O$) by yellow prussiate of potash, but not at all by the red prussiate of potash (showing the absence of protochloride) sp. gr.; 1·44. A fluid drachm diluted with 2 fluid ounces of water gives, upon the addition of an excess of solution of ammonia, a reddish brown precipitate (hydrated peroxyde), which, when well washed and incinerated, weighs 15·62 grains. When the solution is exposed to the air, or when it is precipitated by a small quantity of caustic alkali, a hydrated ferric oxychloride is formed, slightly soluble in water. In estimating the quantity of peroxyde, it is therefore desirable to add the solution of perchloride to the ammonia, and not *vice versa.*

Action. Uses.—It may be used internally as an astringent tonic, in doses of 5 to 10 minims diluted with water. Externally, it is a powerful styptic, and may be employed to arrest hæmorrhage; it is too strong to be applied to an extensive mucous surface. Injected into the vessels it causes coagulation of the blood, and has been thus made use of to cure aneurismal tumours. It is used in making the following two preparations:—

2. **Liquor Ferri Perchloridi,** *P.B. Solution of Perchloride of Iron.*

This is prepared by diluting 1 volume of the strong solution with 3 volumes of *water.* It is of the same strength as a tincture of perchloride of iron.

Dose.—In 10 to 30 minims.

3. **Tinctura Ferri Perchloridi,** *P.B. Tincture of the Perchloride* or *Sesquichloride of Iron.*

Preparation.—Mix together 5 fluid ounces of the strong solution of *perchloride of iron,* 15 fluid ounces of *rectified spirit,* and preserve in a stoppered bottle.

It has the odour of hydrochloric æther, a little being formed by the action of a small quantity of free acid on the alcohol. It has a yellowish red colour, and the reactions of the Liquor ferri perchloridi.

Test.—Sp. gr. 0·922. A fluid ounce yields a precipitate with ammonia equal to 31 grains of anhydrous peroxyde.

Incompatibilities.—Alkalies, earths and their carbonates; astringent vegetable solutions, which form an inky fluid with the tincture; mucilage.

Action. Uses.—This is the preparation of the perchloride most generally employed both for external and internal use. As a styptic, it is applied to warty growths of the mucous membrane, and to exuberant granulations; to check hæmorrhage in epistaxis, for this purpose it should be diluted with four parts of water and injected with a syringe, or the nares should be plugged with a piece of sponge saturated with the solution. Dr Barnes has advocated its use as an intra uterine injection in dangerous flooding. For this purpose a mixture of 1 part of tincture and 9 parts of water may be used. It forms a complete membranous cast of the uterine cavity, composed of closely-adherent epithelium. Intravenous injections have been recommended for the treatment of varix and aneurisms, but it is a most dangerous remedy to introduce into the blood-vessels, for a few drops of the perchloride will usually plug a vein for a very considerable distance.

Internally, it acts as a strong astringent tonic, causing headache and constipation. In large doses it is irritant. In an adult male under my care at King's College Hospital, large doses, dispensed by mistake, produced severe jaundice, lasting many days. I attributed the icterus to inflammatory occlusion of the duodenal orifice of the common duct. In internal hæmorrhage, due to debility, it is very suitable; but in persons of full habits its use is contraindicated, and it may increase the hæmorrhage rather than restrain it. This I have observed to be the case in the hæmaturia of gouty subjects, associated with gravel or congestion of the prostate. In amenorrhœa perchloride of iron is emmenagogue. On this account it is generally considered an inappropriate remedy in pregnancy; but this is based, I believe, upon an erroneous notion of its emmenagogue action, which is most marked in debilitated subjects. I have given the drug in leucorrhœa and general debility, for long periods, to several hundred pregnant women in all stages of pregnancy, and to some during the whole period of gestation, and have only noted abortion in one case, that of a multipara, and the accident in this case was attributed to some other cause. I may illustrate its use in the pregnant condition thus: in the premonitory bleeding in a case of placenta prævia in a robust subject, I should consider perchloride of iron inappropriate, as liable to excite the hæmorrhage; but if the patient have been reduced to a partially anæmic condition by one or more outbursts of hæmorrhage, I should regard the perchloride as a suitable remedy, and one most likely to prevent a recurrence of the hæmorrhage.

The same remarks apply to cerebral congestion. In plethoric subjects the use of the perchloride might promote cerebral hæmorrhage, whereas in the congestion of debility it is a most valuable remedy. It is not suited for the relief of constitutional anæmia, the non-astringent chalybeates being the proper remedies for this condition. On account of its constipating action, it should be prescribed with aperients.

Dose.—10 to 30 minims, in some suitable diluent.

4. Ferri Ammonio-Chloridum. *Ammonio-Chloride of Iron. Ferrum Ammoniatum.*

Contains in 100 parts, 15 $\mathbf{Fr_2Cl_6}$ and 85 $\mathbf{H_4NCl}$.

This preparation was discovered by Basil Valentine in the fourteenth century, and has been employed in medicine under various names. It is composed of a mixture of a double chloride of ammonium and iron ($Fe_2Cl_6 + 2H_4NCl$), with a large excess of chloride of ammonium.

Preparation.—Digest 3 ounces of *peroxyde of iron* in 10 fluid ounces of *hydrochloric acid*, in a proper vessel in a sand bath for two hours; add 2½ pounds of *chloride of ammonium*, first dissolved in 3 pints of *water*. Strain and evaporate to dryness. Rub the residue to powder.

Characters and Tests.—It is an orange-coloured powder, formed of small crystalline grains, which have a saline and astringent taste, but little odour. It is deliquescent, very soluble in both water and alcohol. Its nature is recognised by potash or caustic lime, which displaces ammonia; and the iron and chlorine by their appropriate tests. Mr Phillips has ascertained that it yields about 7 per cent. of peroxyde of iron.

Incompatibilities.—Alkalies and their carbonates, lime water, astringent vegetable infusions.

Action. Uses.—Those of perchloride of iron and chloride of ammonium.

Dose.—3 to 10 grains in syrup, or bitter but not astringent extract, or the following preparation:—

5. **Tinctura Ferri Ammonio-Chloridi,** *P.L. Tincture of Ammonio-chloride of Iron.*

A solution of 4 ounces of the salt in 10 fluid ounces each of proof spirit and water. 1 fluid ounce contains 5·8 grains of perchloride of iron.

This preparation is convenient for internal exhibition. It is only ⅕th the strength of the Tinctura ferri perchloridi.

Dose.—1 to 2 fluid drachms.

SULPHIDES OF IRON.

Iron combines with sulphur in five different proportions; of these the proto- or ferrous sulphide, sulphuret of iron ($\mathbf{FeS}$), and the bisulphide or ferric bisulphide ($\mathbf{FeS_2}$), are the most important, and the only ones which require notice in this work.

1. **Sulphide of Iron,** *B.P.* $FeS = 44$ or $\mathbf{FeS} = 88$.

F. *Sulphure de Fer.* G. *Schwefeleisen.*

This is prepared by the direct combination of the elements, thus:—Apply the end of a rod of iron, heated to a white heat, to the end of a roll of sulphur, and allow the sulphide of iron, as it is formed, to run into a vessel of water. As the iron and sulphur combine together bright sparks are emitted, and the melted sulphide falls into the water as light-brown coloured globules. Thus prepared it is apt to contain an excess of sulphur. The protosulphide may be obtained in the hydrated form by precipitating a solution of a protosalt of iron with a solution of a hydrosulphide of one of the alkali metals, thus: $\mathbf{2KHS + FeSO_4 + H_2O = FeS,H_2O + H_2S + K_2SO_4}$.

Exposed to the air this variety absorbs oxygen, and is converted into a mixture of sulphur and peroxyde of iron.

The anhydrous form is dissolved by dilute sulphuric or hydrochloric acid, with evolution of $\mathbf{H_2S}$ (see p. 60). Nitric acid sets the sulphur free and peroxydises the iron.

Pharmaceutical Uses.—The disengagement of sulphuretted hydrogen (see p. 60).

IRON LUTE.—Sulphur and iron, when mixed in a state of fine powder and moistened, combine with such energy as to result often in ignition; and an excellent lute for the joints of iron apparatus may be formed by a mixture of 60 parts of finely sifted iron filings, 2 parts of chloride of ammonium in fine powder, and 1 part of sublimed sulphur. The powder is made into a paste with water and applied immediately. It soon becomes hot, expands, disengages sulphuretted hydrogen and ammonia, and then sets and becomes as hard as iron itself.

2. **Bisulphide of Iron**: $FeS_2 = 60$ or $\mathbf{FeS_2} = 120$.

Contains in 100 parts, **Fe** 46·67 and **S** 53·33.

It is found native as *iron pyrites* or *mundic*, in cubes or dodecahedra (see p. 158), of the colour of brass; sp. gr. 4·98. It is one of the sources of sulphur (see p. 49). If moistened and exposed to the air it absorbs oxygen, both constituents are oxydised, and it is ultimately converted into sulphate of iron (see p. 192).

FERRI SULPHAS, *P.B.* *Sulphate* or *Protosulphate of Iron.*

$FeOSO_3 + 7HO = 76 + 63$ or $\mathbf{FeSO_4,7H_2O} = 152 + 126$.

Ferrous Sulphate. Green Vitriol. Copperas. Sal Martis.
F. *Sulfate de Fer.* G. *Schwefelsaures Eisenoxydul. Eisenvitriol.*

Contains in 100 parts, **FeO** 25·61, $\mathbf{SO_3}$ 28·77, and $\mathbf{H_2O}$ 45·32.

This salt was known to the ancients. It is mentioned in the *Amera Cosha* of the Hindoos (*Hind. Med.* p. 44), and is used by them, as by the Romans in the time of Pliny, in making ink. It occurs native, and being soluble is found in some mineral waters. It is also made artificially on a large scale for use in the arts by exposing moistened pyrites (see sulphides of iron) to the air. It may be prepared in a state of purity by dissolving pure iron in dilute sulphuric acid. This is the process prescribed in the Pharmacopœia. The sulphate of iron so formed is purified by crystallisation.

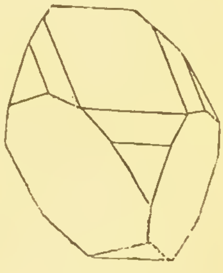

Fig. 41.

Preparation.—Pour 1½ pint of *water* on 4 ounces of *iron wire* in a porcelain dish, add 4 fluid ounces of *sulphuric acid*, and when the disengagement of hydrogen (see p. 37) has nearly ceased, boil for ten minutes. Filter, and after 24 hours separate the crystals which have been deposited, and dry them on filtering paper placed on porous tiles, and preserve from the air.

Characters and Tests.—In oblique rhombic prisms (fig. 41); sp. gr. 1·82; of a pale greenish blue colour (the commercial salt has a grass green colour from the presence of a little persulphate), and styptic inky taste; insoluble in rectified spirit, soluble in twice its weight of cold and about one-third of its weight of boiling water.

It is less soluble at 220° than at 194°, when 100 parts of water dissolve 370 parts of the salt. The aqueous solution is clear, and gives a white precipitate ($BaSO_4$) with chloride of barium, a blue one (Fe_32FeCy,H_2O) with the red, and a nearly white or light blue one with the yellow prussiate of potash. It gives no precipitate with sulphuretted hydrogen (see characters of salts of iron, p. 197), the solution of the salt being acid. The crystals effloresce slightly in the air, and absorbing oxygen, become brownish on the surface. The aqueous solution absorbs oxygen freely, and a rusty precipitate, basic persulphate ($2Fe_2O_3,SO_3,3H_2O$) falls, while a solution of normal persulphate is formed. Heated below 500° the salt loses 6 equivs. of its water of crystallisation, and is reduced to a dry white powder (Ferri sulphas exsiccata). At a red heat the sulphate is decomposed, yielding a residual colcothar (peroxyde of iron) and "Nordhausen" oil of vitriol.

Aqueous solution of sulphate of iron has the property of absorbing nitric oxyde freely, forming a deep brown solution, and this quality is available for the detection of nitric acid (see p. 73).

Impurities.—Sulphate of iron is liable to be contaminated with *persulphate* (indicated by an immediate blue precipitate with yellow prussiate of potash); a yellowish insoluble *oxysulphate* (see above, forming a rusty residue on solution of the salt); *copper* (detected by the blue colour produced by supersaturating the solution with ammonia (see p. 233). *Zinc* may be detected by peroxydising the solution with nitric acid, and then precipitating with excess of ammonia; on expelling the ammonia from the filtrate by heat the oxyde of zinc is deposited in white floculi. Commercial sulphate (the chief source of which is alum shale) may also contain traces of zinc, manganese, alumina, magnesia, and lime; and as it cannot easily be purified from these, the Pharmacopœia has properly prescribed the above mode of preparation.

Incompatibilities.—Alkalies and their carbonates, salts of calcium and of barium, astringent vegetable solutions, with which it forms an inky fluid.

Actions. Uses.—Sulphate of iron is more directly restorative than any other chalybeate, gaining admission into the blood much more rapidly than the astringent persalts, and hence it is the appropriate form of iron in anæmia, and in diseases of the spleen and lymphatic system which lead to this condition. It is but slightly astringent, and in full doses sometimes acts as a laxative on account of its local irritant action. The astringent influence often attributed to this salt is really due to the increase in the density of the blood which attends its use. In anæmia the red corpuscles, which are the heaviest constituent of the blood, and occupy half its entire bulk, are reduced to a half, a third, or even a sixth of their usual proportions, and the blood becomes thin and watery. The use of a suitable chalybeate restores the blood to a healthy state by the regeneration of its corpuscles, as a consequence, checks the unnatural fluxes which so often attend the anæmic state, and ultimately excites and induces the natural discharges. Hence the effect of a chalybeate in removing passive hæmorrhage or leucorrhœa, and in re-establishing the menstrual function.

Dose.—1 to 10 grains in pills, with bitter aromatic extracts; with quinine, calumba, or quassia in solution; or combined with sulphate of magnesia, a little free sulphuric acid, and some aromatic water. It should always be dispensed with distilled water.

1. **Pilula Aloes et Ferri,** *P.B.* *Pill of Aloes and Iron.*

Preparation.—Mix 1½ ounce of *sulphate of iron*, 2 ounces of *Barbadoes aloes*, 3 ounces of *compound powder of cinnamon*, and 4 ounces of *confection of roses*, and reduce them to an uniform mass.

Dose.—5 to 10 grains.

2. **Ferri Sulphas exsiccata,** *P.B.* *Dried Sulphate of Iron.*

$FeO,SO_3,HO=85$ or $\mathbf{FeSO_4,H_2O}=170$.

Preparation.—Expose *sulphate of iron* in a porcelain or iron dish to a heat commencing at 212°, which may be finally raised to 400°, until aqueous vapour ceases to be given off. Reduce to a fine powder, and preserve in a stoppered bottle. Six of the seven molecules of the water of crystallisation are thus expelled. At a higher temperature sulphuric acid is given off. The preparation contains nearly twice as much sulphate of iron as the crystalline form; it is convenient for exhibition in the form of pills.

Dose.—1 to 5 grains.

3. **Ferri Sulphas granulata,** *P.B.* *Granulated Sulphate of Iron.*

$FeOSO_3+7HO$ or $\mathbf{FeSO_4,7H_2O}$.

This is a repetition of the sulphate, and is prepared in the same way, excepting that the solution of sulphate produced by the action of sulphuric acid on iron wire is filtered into rectified spirit, instead of being crystallised. As the sulphate is insoluble in spirit it separates in minute crystals, which are aggregated together in granules. The ordinary sulphate retains a little solution in the interstices of the crystals, which becoming peroxydised stains the crystals with rusty blotches. This defect, which is more optical than therapeutical, is removed by the above process.

Characters and Tests.—In small granular crystals of a pale greenish blue colour. In other respects corresponds to sulphate of iron.

4. **Solution of Sulphate of Iron,** *P.B.*

It is composed of 10 grains of the granulated sulphate in a fluid ounce of water. It should be recently prepared. Employed as a test for nitric acid (see p. 71).

FERRI CARBONAS. *Carbonate of Iron.*

$FeOCO_2=58$ or $\mathbf{FeCO_3}=116$.

Ferrous Carbonate. F. *Carbonate de Fer.* G. *Kohlensaures Eisen.*

This is obtained by precipitating with an alkaline carbonate a solution of any protosalt of iron, *e.g.*, the sulphate. A soluble sulphate of potash or of soda is formed in the solution, and an insoluble carbonate of iron is precipitated. This is at first of a greenish-white colour, but becomes brownish-red in the air, being converted into the peroxyde. The protosalts are more readily absorbed than the persalts, and in order to preserve the carbonate in this condition, a varnish of sugar is employed. It is used in the forms:—

1. **Ferri Carbonas saccharata,** *P.B. Saccharated Carbonate of Iron.*

Carbonate of iron, $FeOCO_2$ or $FeCO_3$, mixed with peroxyde of iron and sugar, the carbonate forming at least 75 per cent. of the mixture.

Preparation.—Dissolve 2 ounces of *sulphate of iron* and 1½ ounce of *carbonate of ammonia*, each in half a gallon of water, and mix with brisk agitation in a deep cylindrical vessel. Cover this as accurately as possible, and set by for twenty-four hours, then separate the supernatant solution with a syphon, pour on a gallon of water, stir well, and after subsidence again remove the clear fluid. Collect the carbonate on a calico filter, press out the water, and then rub it in a mortar with 1 ounce of finely powdered *sugar*, and dry at a temperature not exceeding 212°: $FeSO_4 + (H_4N)_2CO_3 = FeCO_3 + (H_4N)_2SO_4$.

To prevent peroxydation the precipitated carbonate is carefully excluded from the air during the process of washing. By admixture, with the sugar while in the moist state, the particles of powder are invested with a thin pellicle, and thus protected from the action of the air. A little peroxyde is unavoidably formed, owing to the length of the process.

Characters and Tests.—Small coherent lumps of a grey colour, and sweet feeble chalybeate taste. It dissolves with effervescence in warm hydrochloric acid diluted with half its volume of water, and the solution gives but a very slight precipitate ($BaSO_4$) with chloride of barium (the sulphate of ammonia not being completely washed out). 20 grains dissolved in excess of hydrochloric acid, and diluted with water continue to give a blue precipitate with the red prussiate of potash (showing presence of protosalt), until at least 208 grain measures of the volumetric solution of bichromate of potash have been added (indicating a quantity of protocarbonate) equal to 57 per cent.

Action. Uses.—An excellent form of a ferruginous preparation, and very suitable for children and patients having an irritable mucous membrane, for it is quite devoid of irritant properties.

Dose.—10 to 30 grains in powder, lozenge, or pill, as in the next preparation.

2. **Pilula Ferri Carbonatis,** *P.B. Pill of Carbonate of Iron.*

This is composed of one part of *confection of roses*, and 4 parts of *saccharated carbonate of iron*, beaten together into an uniform mass.

Dose.—5 to 30 grains twice or thrice a day.

The *Pilules de Vallet* are a mixture of sulphate of iron, carbonate of soda, honey, and sugar. The carbonate in this combination is more liable to decomposition than the Pilula ferri carbonatis. *Pilules de Blaud* are made similarly with carbonate of potash and gum arabic, and are a close imitation of the following mixture:—

3. Mistura Ferri composita, *P.B.* *Compound Mixture of Iron. Griffith's Mixture.*

Preparation.—Rub together 60 grains each of *myrrh* and *sugar*, and 30 grains of *carbonate of potash*, and form them into a thin paste by the addition of a little rose water; then gradually add more *rose water* and 4 fluid drachms of *spirit of nutmeg*, until about 8 ounces of milky fluid is formed, then add 25 grains of *sulphate of iron* dissolved in about 2 ounces of rose water, and mix thoroughly to form 10 fluid ounces, and preserve as much as possible from the air.

The green hydrated protocarbonate of iron remains suspended in the mixture, which is alkaline from excess (about 15 grains) of carbonate of potash, and contains the sulphate of potash in solution. The bottle in which it is preserved should be kept full, in order to exclude air. The mixture gradually absorbs oxygen, and turns from grass-green to yellowish-brown, with the formation of hydrated peroxyde. The carbonic acid escapes. If it has lost its green colour it is unfit for use.

Incompatibilities.—Acids and acidulous salts, vegetable astringents.

Action and Uses.—Antacid (from free carbonate) and chalybeate, and free from astringent or irritating properties; it is, therefore, especially adapted for use in enfeebled states of the system.

Dose.—1 to 2 ounces two or three times a day.

4. Liquor Ferri Carbonatis effervescens.

As the hydrated carbonate is soluble in carbonic acid water to the extent of about 1½ grain to the pint, an agreeable solution may be prepared by mixing together 3 grains of sulphate of iron (=1¼ of carbonate), 80 grains of sugar, 54 grains of bicarbonate of soda mixed intimately with 60 grains of tartaric acid, throwing them into a soda water bottle, corking it immediately, and agitating.

FERRI LACTAS: $FeO,C_6H_5O_5,3HO$ or $Fe2C_3H_5O_3,3H_2O$.

Lactate of the Protoxyde of Iron. Ferrous Lactate.

This mild chalybeate is obtained as a greenish-white powder, or in greenish acicular crystals, by the direct action of a dilute solution of lactic acid on iron filings. It has also been made by decomposing a solution of 98 parts of crystallised sulphate of iron with one of 100 grains of lactate of lime. It may be prescribed in the form of lozenges or of syrup. It has been extensively used in France, and is no doubt an admirable form of exhibiting iron.

Dose.—1 to 5 grains.

FERRI MALAS: $2FeO,C_4H_4O_8$ or $FeC_4H_4O_5$. *Malate of Iron.*

Is a form prescribed in the old Prussian Pharmacopœia. It is procured by digesting one part of iron nails or wire along with 4 parts of apple juice for some days, then evaporating the liquid to one-half, filtering and concentrating to the consistence of an extract.

Ferri Arsenias, *P.B.* *Arseniate of Iron,*

Will be best considered among the compounds of arsenic.

LIQUOR FERRI PERSULPHATIS, *P.B.* *Solution of Persulphate of Iron.*

$Fe_2O_3,3SO_3$ or Fe_23SO_4 dissolved in water.

Preparation.—Add 6 fluid drachms of *sulphuric acid* to 10 ounces of *water*, and dissolve 8 ounces of *sulphate of iron* in the mixture by the aid of heat, then add to it 6 fluid drachms of *nitric acid* diluted with 2 ounces of *water*, and concentrate by boiling until, by a sudden disengagement of ruddy vapours (NO_2), the fluid changes from black to red. A drop of the solution is now tested with red prussiate of potash, and if a blue precipitate forms, a few additional drops of nitric acid should be added and the boiling renewed, in order that the whole of the sulphate may be converted into persulphate. When the solution is cold, make the whole measure 11 fluid ounces by the addition, if necessary, of water.

In this process the hydrogen of both acids is oxydised to form water, as the expense of the nitric acid, which is reduced to nitric oxyde, the liberated sulphion attaches itself to the sulphate of iron, converting it from proto- into persalt:

$$6FeSO_4 + 3(H_2SO_4) + 2(HNO_3) = 3(Fe_23SO_4) + 4H_2O + 2NO.$$

The nitric oxyde dissolves in the solution as fast as it is formed, giving it a black colour, but it is subsequently expelled with the change of colour and composition (see p. 55) above mentioned.

Characters and Tests.—A dense solution, sp. gr. 1·441, of a dark red colour, inodorous, and very astringent, miscible in all proportions with alcohol and water. Diluted with 10 volumes of water, it gives a white precipitate with chloride of barium ($BaSO_4$), and a blue one with yellow (persalt), but not with red (absence of protosalt) prussiate of potash. One fluid drachm diluted with 2 ounces of water gives, with excess of ammonia, a precipitate which, when well washed and incinerated, weighs 11·44 grains (of anhydrous peroxyde, showing the proper amount of iron). The solution yields a yellowish white deliquescent mass on evaporation. Persulphate of iron forms double salts with the sulphates of the alkali metals which have the constitution of alum (iron alums), and are very soluble and very astringent. The potash salt ($K_2SO_4,Fe_23SO_424H_2O$) crystallises in octohedra of a pale violet colour, but is liable to spontaneous decomposition, forming a brown deliquescent mass. The ammonium salt ($H_4NSO_4Fe_23SO_4,24H_2O$) is tolerably permanent; both crystallise like all the other alums in regular octohedra.

Pharmaceutical Uses.—In the preparation of Ferri et ammoniæ citras, Ferri et quinæ citras, Ferri oxydum magneticum, Ferri peroxydum humidum, Ferrum tartaratum, and Tinctura ferri acetatis.

LIQUOR FERRI PERNITRATIS, *P.B.* *Solution of Pernitrate of Iron.*

$Fe_2O_33NO_5$ or Fe_26NO_3 dissolved in water.

Preparation.—Dilute 4½ fluid ounces of *nitric acid* with 16 ounces of *water*, and put 1 ounce of fine *iron wire* into the mixture. If the action be too violent, moderate it by the addition of a little water. When the iron is dissolved, filter the solution, and add water that it may measure 1½ pint.

The iron combines with a portion of the nitric acid to form a soluble pernitrate, its hydrogen being previously removed by the oxygen of another portion, water and nitric oxyde (NO) being simultaneously formed, the latter escaping with vehement effervescence and forming ruddy fumes of peroxyde (NO_2) as soon as it comes in contact with the air:—$2Fe + 8HNO_3 = Fe_26NO_3 + 4H_2O + 2NO$.

Characters and Tests.—A clear solution of a reddish brown colour, slightly acid and astringent to the taste. It gives a blue precipitate with the yellow, but none (absence of protosalt) with the red prussiate of potash. If placed in a test tube with half its volume of pure sulphuric acid, and a solution of sulphate of iron is added, the whole assumes a dark brown colour (showing the presence of a nitrate, see p. 73). Sp. gr. 1·107. One fluid drachm treated with an excess of solution of ammonia, gives a precipitate, which, when washed, dried, and incinerated, weighs 2·6 grains of anhydrous peroxyde.

The same quantity of Liquor and Tinctura ferri perchloridi yields nearly 4 grains, the solution of pernitrate is therefore proportionately weaker. Prismatic crystals of the hydrated salt may be obtained on evaporation.

Action. Uses.—Those of the perchloride over which it possesses no advantage.

Dose.—10 to 40 grs. with water or infusion of quassia or calumba.

TINCTURA FERRI ACETATIS, *P.B.* *Tincture of Acetate of Iron.*

$Fe_2O_3,3C_4H_3O_3$ or $Fe_26C_2H_3O_2$ dissolved in alcohol.

Preparation.—Dissolve 2 ounces of *acetate of potash* in 10 fluid ounces of *rectified spirit*, and add 2½ fluid ounces of *solution of persulphate of iron* to 8 fluid ounces more of spirit; mix the two solutions in a two-pint bottle, and shake them well together at intervals during an hour. Then filter, and wash the residue with enough rectified spirit to make the filtrate measure 1 pint:

$$Fe_2 3SO_4 + 6KC_2H_3O_2 = Fe_2 6C_2H_3O_2 + 3K_2SO_4 .$$

The metals simply exchange acids, the sulphate of potash is precipitated on account of its insolubility in alcohol and removed by filtration, the peracetate of iron remains in solution.

A pleasant astringent chalybeate, originally prescribed in the Dublin Pharmacopœia.

Dose.—5 to 30 minims.

FERRI PHOSPHAS, *P.B.* *Phosphate of Iron.*

$3FeO,PO_5$ or $Fe_3 2PO_4$ partially oxydated.

This preparation closely resembles *vivianite* or native hydrated blue phosphate of iron.

Preparation.—Dissolve 3 ounces of *sulphate of iron* in 2 pints of boiling water, and 2½ ounces of *phosphate of soda* and 1 ounce of *acetate of soda* in another 2 pints. Mix the solutions, and after briskly stirring, collect the precipitated phosphate in a calico filter, and wash it with hot water till the filtrate ceases to give a precipitate with chloride of barium (showing that the sulphate of soda has been completely removed). Finally, dry the precipitate at a temperature not exceeding 120°.

Phosphate of soda and sulphate of iron alone give the phosphate, but sulphuric acid is at the same time liberated, and prevents the complete precipitation of the ferrous phosphate: $3FeSO_4 + 2Na_2HPO_4 = Fe_3 2PO_4 + 2Na_2SO_4 + H_2SO_4$. As the phosphate is insoluble in acetic acid, the acetate of soda is used to give base to the sulphuric acid (see acetates), as fast as it is formed, and thus free acetic acid remains in the supernatant liquor.

Characters and Tests.—A slate-blue amorphous powder, insoluble in water, soluble in hydrochloric acid. The solution yields a precipitate with both yellow and red prussiate of potash, that with the latter being the more abundant (indicating more protosalt than persalt), and when treated with tartaric acid and an excess of ammonia (see ammonio-tartrate of iron), and subsequently with the solution of ammonio-sulphate of magnesia, lets fall a crystalline precipitate (triple phosphate, see p. 66). When the salt is digested in hydrochloric acid with a plate of pure copper, a dark deposit (arsenicum) does not form on the metal; 20 grains, dissolved in hydrochloric acid, continue to give a blue precipitate with red prussiate of potash until 250 gr. measures of the volumetric solution of bicarbonate of potash have been added (indicating a proper proportion of protosalt).

Like all the other protosalts of iron, this preparation is prone to oxydation, and should therefore be excluded from the air.

Action and Uses.—A mild chalybeate, not very active on account of its insolubility, but it is supposed to be easily assimilated, and to be beneficial in rickets, mollities ossium, and in strumous diseases, especially those affecting the bones. According to MM. Paquelin and L. Jolly (*Acad. des Scien.* 1874), the iron exists in the globulin of the blood in the state of tribasic phosphate of the protoxide. If this be so, the preparation under consideration would be a more immediate restorative than any other preparation of iron, if it be readily absorbed as such.

Dose.—5 to 10 grains in the form of pill; in combination with phosphoric acid which renders it soluble; or in the following form:—

1. **Syrupus Ferri Phosphatis,** *P.B.* *Syrup of Phosphate of Iron.*

1 fluid drachm contains 1 grain of the salt and ½ fluid drachm of dilute phosphoric acid.

Preparation.—Dissolve 224 grains of *granulated sulphate of iron* in 4 ounces of *water*, and 200 grains of *phosphate of soda* and 74 grains of *acetate of soda* in 4 ounces more; mix the two solutions, and, after careful stirring, transfer the precipitate to a calico filter, and wash it with water till the filtrate ceases to be affected by chloride of barium. Then press the precipitate strongly between folds of bibulous paper, and add to it 5½ fluid ounces of *dilute phosphoric acid.* As soon as the precipitate is dissolved, filter the solution, add 8 ounces of *refined sugar*, and dissolve without heat. The product should measure 12 fluid ounces.

The blue phosphate is formed as above, and then dissolved in phosphoric acid. It has a strong acid taste, each drachm containing nearly ½ fluid drachm of the dilute acid.

Dose.—30 to 60 minims; for children, 10 to 30 minims. It must be freely diluted on account of the large proportion of acid present.

FERRUM TARTARATUM, *P.B.* *Tartarated Iron.*

$KO,Fe_2O_3,C_8H_4O_{10}+2HO$ or $KFeO,C_4H_4O_6,H_2O$.

Tartrate of Potash and Iron. L. *Ferri Potassio-Tartras.*
F. *Tartrate de Potasse et de Fer.* G. *Eisenweinstein.*

Preparation.—Mix 10 fluid ounces of *solution of ammonia* with 3 pints of *water*, and to this add gradually 5½ fluid ounces of *solution of persulphate of iron* previously diluted with 2 pints of *water*, stirring constantly and briskly. Let the mixture stand for two hours, stirring it occasionally, then put it on a calico filter, and when the liquid has drained away, wash the precipitate with water until that which passes through the filter ceases to give a precipitate with chloride of barium (showing freedom from sulphate of ammonia). Mix the washed and drained precipitate intimately with 2 ounces of *acid tartrate of potash* in powder in a porcelain dish, and let the mixture stand for twenty-four hours; then, having applied a gentle heat, not exceeding 140°, add gradually 1 pint of *water*, and stir constantly until nothing more will dissolve. Filter; evaporate at a temperature not exceeding 140° to the consistence of syrup, and dry it in thin layers on flat porcelain or glass plates in a drying closet at 120°. Remove the dry salt in flakes, and keep it in stoppered bottles.

In this process the acid tartrate of potash is converted into a neutral bibasic salt by the combination of an equivalent of peroxyde of iron. This latter is prepared in the hydrated form by precipitating the solution of persulphate with ammonia. In drying, the heat must be kept within certain limits, otherwise the salt will be decomposed with the separation of peroxyde.

Characters and Tests.—Thin transparent slightly deliquescent scales, of a deep garnet colour, slightly sweetish and astringent in taste, soluble in four times its weight of water, and sparingly soluble in spirit. The aqueous solution, when acidulated with hydrochloric acid, gives a copious blue precipitate with the yellow, but none with the red prussiate of potash (absence of protosalt). Boiled with solution of soda, peroxyde of iron separates, but no ammonia (absence of citrate of iron and ammonia, which it resembles) is evolved, and the filtered solution, when slightly acidulated by acetic acid, gives, on cooling, a crystalline precipitate ($KHC_4H_4O_6$, cream of tartar). By incinerating 50 grains of the salt at a red heat, washing what is left with water (to remove carbonate of potash, see p. 140), and again incinerating, a residue of peroxyde of iron is obtained, weighing 15 grains.

This salt is uncrystallisable, and may be prepared in the form of dark brown powder. The solution is of a brownish colour, and remains unchanged for a considerable time. It is remarkable for not being decomposed by ammonia or its carbonate at any temperature, nor by the other alkalies or their carbonates without the aid of heat. It is also unaffected by ferrocyanide of potassium until a few drops of one of the stronger acids are added. In these reactions it resembles the ferrocyanides, and is supposed, like them, to contain iron *in the acid part* (*Potassæ Ferro-tartras*, Pereira). Vegetable astringents cause the usual black precipitate.

Incompatibilities.—Strong acids, lime water, acetate of lead, sulphuretted hydrogen, vegetable astringents.

Action and Uses.—A mildly astringent chalybeate tonic.

Dose.—10 to 30 grains, in the form of pill or solution, with an aromatic, or as one of the two preparations next following:—

1. **Vinum Ferri**, *P.B.* *Iron Wine.*

Preparation.—Macerate 1 ounce of *fine iron wire* (about No. 35) in 1 pint of *sherry* for thirty days in a closed vessel, the iron being almost, but not quite, wholly immersed in the wine, and the vessel frequently shaken, and the stopper removed; then filter.

A portion of the iron becomes peroxydised and is dissolved by the acid tartrate of potash, or free vegetable acid present in the wine, and combined as potassio-tartrate, malate, or acetate of the peroxyde. The quantity of iron dissolved is nearly in inverse ratio to the quality of the wine. Thus, Cape wine dissolves much more than dry sherry. Hock has been recommended for use on account of its acidity.

Prepared according to the above directions, it will contain generally an amount of peroxyde of iron corresponding to six grains of the salt in each ounce. A better process, because it insured an uniform preparation, is that of the P.B. 1864. This merely consisted in dissolving 160 grains of tartarated iron in 1 pint of sherry = 8 grains in the fluid ounce.

Action. Uses.—An admirable chalybeate stimulant, much used for children and young people.

Dose—60 minims to ½ ounce or more, according to age.

2. **Mistura Ferri Aromatica,** *P.B. Aromatic Mixture of Iron.*

Take 1 ounce of *pale cinchona bark* in powder, ½ ounce of *calumba root* in coarse powder, ¼ ounce of *cloves* bruised, ½ ounce of *fine iron wire*, 3 fluid ounces of *compound tincture of cardamoms*, ½ fluid ounce of *tincture of orange peel*, and *peppermint water* a sufficiency. Macerate the dry vegetables and the iron with 12 fluid ounces of the peppermint water in a closed vessel for three days, agitating occasionally; then filter and add enough peppermint water to make the product measure 12½ fluid ounces; to this add the tinctures, and preserve in a well-stoppered bottle.

Introduced from the old Dublin Pharmacopœia. A portion of the iron becomes oxydised, and dissolves in the organic acids of the mixture (kinic, tartaric, citric, &c).

Dose.—1 to 2 fluid ounces.

FERRI ET AMMONIÆ TARTRAS. *Tartrate of Iron and Ammonia.*

$H_4NOFe_2O_3,C_8H_4O_{10}+4HO$ or $H_4NFeOC_4H_4O_6+2H_2O$.

Preparation.—The same as the tartarated iron, substituting *acid tartrate of ammonia* ($H_4NH,C_4H_4O_6$) for acid tartrate of potash. The acid tartrate of ammonia is prepared by neutralising ammonia with tartaric acid, observing the quantity required, and then adding this weight more of the acid to the solution.

Characters and Tests.—In brilliant scales or in angular grains, of a dark-brown colour resembling Kino. It has a mild ferruginous taste; is soluble in rather more than its weight of water at 60°; not decomposed by boiling water; insoluble in both alcohol and æther. Boiled with a solution of soda, peroxyde of iron is precipitated and ammonia evolved. It is an eligible preparation of iron, and may be given in doses of 3 to 8 grains in aqueous solution, in pill, or with some confection.

FERRI ET AMMONIÆ CITRAS, *P.B. Citrate of Iron and Ammonia.*

There is some doubt as to the correct composition of this salt. Citric acid is tribasic, and it may be represented as being composed of a molecule each of ammonia, water, and peroxyde of iron, in combination with a molecule of citric acid, thus:

$H_4NO,HO,Fe_2O_3,C_{12}H_5O_{11}+2HO$ or $H_4NH,FeOC_6H_5O_7,H_2O$.

Preparation.—Mix 14 fluid ounces of *solution of ammonia* with 2 pints of *water*, and to this add gradually 8 fluid ounces of *solution of persulphate of iron*, previously diluted with 2 pints of *water*, stirring them constantly and briskly. Let the mixture stand for two hours, stirring it occasionally; then put it on a calico filter, and when the liquid has drained away, wash the precipitate with water until that which passes through the filter ceases to give a precipitate with chloride of barium. Dissolve 4 ounces of *citric acid* in 8 ounces of *water*, and having applied the heat of a water-bath, add the *oxyde of iron*, previously well drained, and stir them together until the whole, or nearly the whole, of the oxyde has dissolved. Let the solution cool, then add of 5½ fluid ounces of *solution of ammonia.* Filter through flannel; evaporate to the consistence of syrup, and dry it in thin layers on flat porcelain or glass plates at a temperature not exceeding 100°. Remove the dry salt in flakes, and keep it in a stoppered bottle.

In the first part of the process a moist peroxyde of iron is prepared. This, when heated with the solution of citric acid, is dissolved, forming an acid citrate of the peroxyde. On adding ammonia to neutralisation it takes the place of a molecule of the basic water, forming a salt having the composition indicated by the formula given above. The heat used in drying is scarcely sufficient in practice, but a higher temperature is apt to drive off some of the ammonia.

Characters and Tests.—In thin transparent scales of a deep red colour, slightly sweetish and astringent in taste. It feebly reddens litmus; is soluble in water, but almost insoluble in rectified spirit. The solution of this salt, acidulated with hydrochloric acid, gives a copious blue precipitate (ordinary Prussian blue, see p. 100) with yellow prussiate of potash, but not with the red prussiate (absence of protoxide). Heated with solution of potash, it evolves ammonia and deposits peroxyde of iron. The alkaline solution from which the iron has separated does not, when slightly supersaturated with acetic acid, give any crystalline precipitate (thus distinguished from tartarated iron, which, under similar conditions, deposits acid tartrate of potash, and proves the absence of tartaric acid, which may be substituted for citric). When incinerated with exposure to the air it leaves not less than 27 per cent. of anhydrous peroxyde of iron, which is not alkaline to litmus (again distinguishing it from tartarated iron, which when incinerated gives a mixture of peroxyde, carbon, and carbonate of potash).

Incompatibilities.—Liquor potassæ. Liquor sodæ. Strong acids.

Action. Uses.—It is a mild preparation, pleasant to the taste, and useful for children and weak persons. It may be given with ammonia or the alkaline carbonates. It is neither irritant nor astringent.

Dose.—5 to 10 grains.

1. **Vinum Ferri Citratis,** *P.B. Wine of Citrate of Iron.*

Contains 8 grains of the double citrate in 1 fluid ounce.

Preparation.—Dissolve 160 grains of *citrate of iron and ammonia* in 1 pint of *orange wine*, and let the solution remain for three days in a closed vessel, shaking it occasionally; afterwards filter.

Dose.—60 minims to ½ fluid ounce.

2. **Effervescing Solution of Citrate of Iron** may be formed by dissolving 10 grains of citrate of iron in half a pint of water, adding 2 fluid drachms of syrup of lemon, and charging the solution with carbonic acid under pressure of five atmospheres.

FERRI ET QUINIÆ CITRAS, *P.B.* *Citrate of Iron and Quinia.*

Preparation.—Dilute 8 fluid ounces of *solution of ammonia* with 2 pints of *water*, and to this add 4½ fluid ounces of *persulphate of iron*, previously diluted with 2 pints of distilled water, stirring briskly at intervals for two hours, then put it on a calico filter and wash the precipitate with water until the filtrate ceases to give a precipitate with chloride of barium (showing freedom from sulphate of ammonia). Mix 1 ounce of *sulphate of quinia* with 8 ounces of water, add 12 fluid drachms of *dilute sulphuric acid*, and dissolve, and then precipitate the quinia with a slight excess of solution of ammonia. Collect it on a filter, and wash with 1½ pint of water.

Dissolve 3 ounces of *citric acid* in 5 ounces of water, apply the heat of a water-bath, add the *moist peroxyde of iron*, and stir. When it is dissolved, add the precipitated quinia, and continue the stirring until this is also dissolved. Let the solution cool, then add in small quantities at a time 12 fluid drachms of *solution of ammonia*, diluted with 2 ounces of water, stirring briskly, and allowing the quinia which separates with each addition of ammonia to dissolve before the next addition is made. Filter the solution, evaporate to the consistence of a thin syrup, and dry in thin layers on flat porcelain or glass plates at 100°. Remove the dry salt in flakes, and keep it in a stoppered bottle.

Characters and Tests.—Thin scales of a greenish golden-yellow colour, somewhat deliquescent, and entirely soluble in cold water. The solution is very slightly acid, and is precipitated reddish-brown by solution of soda (hydrated peroxyde mixed with quinia), white by solution of ammonia (quinia), blue by the yellow and red prussiates of potash (presence of both proto- and persalt of iron), and greyish black (a mixture of black tannate of iron with quinia) by tannic acid. The taste is bitter as well as chalybeate. When burned with exposure to the air it leaves a residue, which when moistened with water is not alkaline to test-paper (absence of potash). 50 grains dissolved in a fluid ounce of water, and treated with a slight excess of ammonia, gives a white precipitate (of quinia), which, when collected on a filter and dried, weighs 8 grains. The precipitate is almost entirely soluble in pure æther, and when burned leaves but a minute residue.

This last test for the estimation of quinine is a very necessary one, as some samples do not contain more than 7 or 8 per cent.

Incompatibilities.—Alkalies and their carbonates. Lime water. Astringent vegetable solutions.

Action.—This salt combines the properties of a non-astringent chalybeate with those of quinia.

Dose.—3 to 15 grains, with an aromatic water.

FERRI VALERIANAS, *Valerianate of Iron.*

$FeO,C_{10}H_9O_3$ or $\mathbf{Fe2C_5H_9O_2}$.

This amorphous salt is prepared by mixing cold solutions of 258 grains of *valerianate of soda* in 10 ounces of water, and 288 grains of *sulphate of iron*, previously converted into persulphate (see p. 214), and dissolved in 8 ounces of water. The precipitated valerianate of iron is collected on a filter, washed with 2 ounces of water, and dried at the ordinary temperature of the air.

Actions.—Those of iron and valerianic acid. In the anæmia which often attends nervous diseases it is a serviceable remedy.

Dose.—1 to 3 grains, in the form of pill.

ZINC. Zn = 32·5 or Zn = 65.

F. *Zinc.* G. *Zink.*

Zinc is considered to have been known as a distinct metal only since the time of Paracelsus. It has long been imported from China into India. The name *Tutenague*, by which the Chinese zinc was known in commerce, is evidently derived from the Tamul, *tutanagum* (Essay Hind. Med. p. 100), and it was at one time called Indian Tin (*Stannum Indicum*). The ores of zinc were employed by the ancients in making brass.

Zinc is found in the state of oxyde and silicate (electric calamine, so called because it becomes electric when heated), but principally as a sulphide (*blende*), and an impure carbonate (*calamine*), which occurs in compact earthy masses of a grey, pinkish, or reddish yellow colour. From both ores it is first converted into oxyde by the process of roasting, and then reduced to the metallic form by the aid of carbonaceous matter, when it may either be fused or sublimed. Until purified by a second distillation, it contains as impurities small portions of other metals, as iron, copper, arsenic, &c.

Properties.—Zinc is white, with a shade of blue, and of considerable brilliancy; sp. gr. from 6·8 to 7·1. At ordinary temperatures it has little ductility or malleability, but is hard and tough. When heated from 210° to 300° it becomes ductile, and may be drawn into wire or beaten or rolled into thin sheets, which may also be done at ordinary temperatures if it be very pure. At 400° it becomes brittle, and may be powdered. It melts at 773°, and, on slowly cooling, crystallises in four-sided prisms, which, on fracture, display a lamellated structure. At a white heat it may be volatilised in close vessels; but in contact with the air it burns vividly, diffusing white fumes of oxyde. Exposed to the air, or kept under water, zinc becomes covered with a thin film of suboxyde, which protects it.

Commercial zinc contains small quantities of lead and iron, often traces of tin and cadmium, and occasionally traces of copper, arsenicum, and sulphur.

The presence of sulphur or of arsenic may be detected by testing the hydrogen gas given off during the solution of the metal in sulphuric acid. If this contains sulphuretted hydrogen it will blacken a piece of paper moistened with a solution of acetate of lead; if arseniuretted hydrogen the gas, when ignited, will blacken a piece of white porcelain held low down in the flame (see tests for arsenic). Carbon or sulphide of lead forms an insoluble residue when the metal is dissolved in sulphuric acid.

1. **Zincum granulatum**, *P.B.* *Granulated Zinc.*

This is a more convenient form of the metal for pharmaceutical uses.

Preparation.—Fuse a pound of *zinc* in an earthern crucible, and pour the liquid metal in a thin stream into two gallons of cold water.

Pharmaceutical Uses.—In the preparation of Zinci chloridum, Liquor zinci chloridi, Zinci sulphas.

Characters of the Salts of Zinc.—Colourless, astringent to the taste. No precipitate in acid solutions (excepting the acetate), with sulphuretted hydrogen. A white hydrated sulphide with *hydrosulphide of ammonium;* a white hydrated oxyde, with *potash, soda*, or *ammonia*, soluble in excess, and a white basic carbonate with *their carbonates*, that produced by carbonate of ammonia being alone soluble in excess of the carbonate. A white precipitate with *ferrocyanide of potassium*,

ZINCI OXYDUM, *P.B.* *Oxyde of Zinc.* ZnO = 40·5 or **ZnO** = 81.

Lana philosophica. Flores Zinci. F. *Oxydc de Zinc.* G. *Zinkoxyd.*

Contains in 100 parts, **Zn** 80·24, **O** 19·76.

This oxyde has been long known in an impure state, by the name of *tutty*, which appears to be of Oriental origin, as the sulphate is still called *suffed tutia*, or white tutia: the sulphates of iron and copper being called *green* and *blue tutia.* (Hindoo Med. p. 100).

Preparation.—By exposing the carbonate in a loosely covered Hessian crucible to a dull red heat, until a portion taken from the centre and cooled no longer effervesces when dropped into dilute sulphuric acid. When the crucible is cold the oxyde is transferred to a stoppered bottle.

Like chalk and carbonate of magnesia, carbonate of zinc loses its carbonic acid at a red heat, and, like lime and magnesia, oxyde of zinc absorbs carbonic acid (though much more slowly than the former) from the air. Hence the necessity of exclusion.

The oxyde thus prepared is of course anhydrous, and is insoluble in ammonia.

Characters and Tests.—A soft, nearly white, tasteless, and inodorous powder, becoming pale yellow when heated. Dissolves without effervescence (CO_2) in dilute nitric acid, forming a solution which is not affected by chloride of barium (absence of sulphate), or nitrate of silver (absence of chlorides), and gives with carbonate of ammonia a white precipitate (of carbonate of zinc), which dissolves entirely without colour in an excess of the reagent (proving absence of lead and the earthy metals), forming a solution which is precipitated white ($ZnSH_2O$) by sulphide of ammonium.

Impurities.—Carbonate of zinc is often sold for the oxyde; and Mr Redwood (P. J. ii. 506) states that the oxydes of zinc of commerce are either basic carbonates or a mixture of basic sulphate and hydrated oxyde, containing only from 64 to 67 per cent. of oxyde. In obtaining this basic sulphate, ammonia is used as the precipitant. It is readily detected by the baryta test. Iron gives a yellow colour to the oxyde; copper a blue colour to a solution in acid, when mixed with an excess of ammonia or its carbonate. Carbonates of lime or lead effervesce with acids, and also remain undissolved (as well as the iron) in ammonia.

Incompatibilities.—Acids and acidulous salts.

Action. Uses.—Oxyde of zinc is readily soluble in dilute acids, and may therefore, after ingestion, be carried into the blood in the form of chloride, lactate, or carbonate. The influence, if any, of a soluble salt on the functions is slight and obscure. It is generally assumed to act as a *mild astringent and tonic*, in a relaxed condition of the involuntary muscular fibre, by virtue of which it checks undue secretion from the skin and mucous membranes; and as a *sedative to the nervous system*, and especially to the motor system, hence it has been freely used in chorea and epilepsy, but with very doubtful success.

In large doses the salts of zinc are irritant, usually producing emesis, and if continued, purging.

Applied to the skin or mucous membranes the soluble salts are stimulant, astringent, and sedative. Thus, when a solution of the sulphate is applied to a congested, irritable, and weeping conjunctiva, it causes at first much smarting and pricking, with increased redness of the blood-vessels, followed by an arrest of the abnormal secretion, and a diminution of the vascularity, and attended by a refreshing feeling of relief and comfort. They are, therefore, beneficial as *local* applications in chronic gastritis and cystitis, in ophthalmia, leucorrhœa, &c., and excoriated and ulcerated surfaces.

The oxyde and carbonate are grateful applications to irritable ulcers, and by their feebly stimulant and astringent action arrest, as they are slowly dissolved by the secretions, profuse fluxes, allay irritation, and promote cicatrization. The antiseptic property of the zinc salts, moreover, enable them to prevent the decomposition which gives rise to irritating and offensive discharges.

Dose.—1 to 5 grains, or more, twice a-day, in the form of a pill.

Unguentum Zinci, *P.B.* *Zinc Ointment.*

80 grains of the oxyde mixed with 1 ounce of benzoated lard.

A mild sedative ointment. The benzoic acid is supposed to prevent the lard from becoming rancid, but it does not do so.

ZINCI CHLORIDUM, *P.B.* *Chloride of Zinc.*

$ZnCl = 68$ or $ZnCl_2 = 136$.

An uncrystallisable, very deliquescent caustic salt. Is fluid and constant at 700°, and may be used as a hot bath for maintaining objects at this temperature. It sublimes unchanged at a red heat. It is prepared by solution of the metal in hydrochloric acid.

Preparation.—Put 16 ounces of *granulated zinc* into a porcelain basin, add by degrees 44 fluid ounces of *hydrochloric acid* diluted with 1 pint of *water*, and aid the action by a gentle heat until hydrogen is no longer evolved. Boil for half an hour, supplying the water lost by evaporation, and allow it to stand on a cool part of a sand-bath for twenty-four hours, stirring frequently. Filter into a gallon bottle, and pour in *solution of chlorine*, by degrees, with frequent agitation, until the fluid acquires a permanent odour of chlorine. Add ½ an ounce of *carbonate of zinc*, or sufficient, in small quantities at a time, and with renewed agitation, until a brown sediment appears. Filter into a porcelain dish, and evaporate until a portion of the liquid, withdrawn on the end of a glass rod and cooled, forms an opaque white solid. Pour it out now into proper moulds, and when the salt has solidified, but before it has cooled, place it in closely-stoppered bottles.

In the above process the zinc merely displaces the hydrogen of the acid. The chlorine is added to convert the iron or tin usually present to the state of persalt (see p. 233), and this is precipitated as peroxyde by the addition of the carbonate of zinc, which dissolves with the evolution of carbonic acid to form chloride.

Characters and Tests.—Colourless opaque rods or tablets, very deliquescent and caustic; soluble almost entirely in water, alcohol, and æther. The watery solution is precipitated white by sulphide of ammonium (ZnS), and nitrate of silver ($AgCl$), but if first acidulated with hydrochloric acid it is not affected by sulphuretted hydrogen (see salts of zinc, p. 223). Its watery solution is not affected by chloride of barium or oxalate of ammonia (absence of sulphuric acid and lime), and is not tinged blue by yellow or red prussiate of potash (absence of iron). Ammonia throws down a white precipitate (hydrated oxyde of zinc), entirely soluble in an excess of the reagent (proving absence of alumina, lime, and iron).

Action. Uses.—A powerful and penetrating caustic; used to destroy nævi, lupus, and cancerous sores. At the same time it prevents and destroys any bad odour. The neighbouring parts should be protected by plaster. As a caustic it produces severe burning pain, lasting for hours. It is sometimes given internally in epilepsy

For the destruction of superficial parts it will be sufficient to rub them with a rod of the chloride until they present a dead white appearance; for the removal of tumours, a fragment proportionate to the size of the tumour, should be introduced through an ulcerated aperture in the tumour or by a suitable incision into the central parts of the tumour, the aperture being plugged with bread crumb to prevent the deliquescent caustic from coming in contact with the healthy skin or mucous membrane.

Dose.—$\frac{1}{2}$ to 1 grain.

1. **Liquor Zinci Chloridi**, *P.B.* *Solution of Chloride of Zinc.*

Preparation.—Make a solution as directed for the solid salt, remove the iron and tin by the same means, and evaporate until it is reduced to 2 pints. 1 fluid ounce contains 366 grains.

"Burnett's disinfecting and antiseptic fluid" is a weaker solution of chloride of zinc; sp. gr. 2·0, and containing 200 grains in a fluid ounce.

Action and Uses.—Chloride of zinc precipitates solutions of albumen and gelatine, and forms with these and the animal and vegetable tissues insoluble compounds. It is, therefore, employed to preserve wood, cotton fabrics, and the animal tissues (for the purposes of dissection) from decay.

By virtue of the foregoing properties chloride of zinc is a powerful deodorising agent when brought in contact with putrescent matters in a fluid or soft state. It not only arrests the putrescent action, but decomposes the sulphides of ammonium and hydrogen which may have been formed, inodorous sulphide of zinc and chloride of ammonium or antiseptic hydrochloric acid being formed. For these purposes a pint of the solution should be mixed with five or six gallons of water. As a wash to putrid ulcers it may be used in the proportion of 2 minims to a fluid ounce.

CARBONATE OF ZINC.

$ZnO,CO_2 = 62·5$ or $ZnCO_3 = 125$.

Contains in 100 parts, ZnO 64·8 and CO_2 35·2.

Calamine is found in various parts of the world. But the same name is applied to two very distinct ores, one being a silicate of zinc and the other a carbonate. The latter is in compact or earthy masses, readily scratched with a knife, and breaking with an earthy fracture. It is also found crystallised. Sp. gr. 3·4 to 4·4. The colour is various; but, as usually seen, it is grey, pinkish, or reddish yellow. It dissolves in nitric and other acids with effervescence, and is not rendered electric by heat, by which characters it is easily distinguished from the silicate, which is also called *Electric Calamine.* The carbonic acid and zinc will be indicated by their respective tests. The crystallised variety is anhydrous.

1. **Calamina Præparata.** *Calamine.*

Is a form of impure carbonate of zinc, and derives its name from the property of adhering to the furnace in the form of reeds. It is prepared by roasting the native carbonate, by which the water and some of the carbonic acid are expelled, then powdering the ore, and separating the finer particles by elutriation, as in the preparation of Creta præparata, and forming it in the same way into little conical masses. It is salmon-coloured, and usually contains oxyde of iron and other impurities. The calamine of commerce is greatly adulterated with chalk and sulphate of baryta, coloured with *Armenian bole.* The following precipitated oxycarbonate is now substituted for prepared calamine, but the latter is still much used as a dusting powder.

2. **Zinci Carbonas,** *P.B.* *Carbonate of Zinc.*

$$ZnO,CO_2 + 2ZnO + 3HO \text{ or } ZnCO_3(ZnO)_2,3H_2O.$$

The so-called carbonate of the Pharmacopœia is an oxycarbonate, for it is not possible to obtain a simple carbonate by double decomposition.

Preparation.—Dissolve 10½ ounces of *carbonate of soda* in a pint of *water* in a capacious porcelain vessel, and pour it into a solution of 10 ounces of *sulphate of zinc*, also dissolved in a pint of water, stirring diligently. Boil for fifteen minutes after effervescence has ceased, and let the precipitate subside. Then wash the precipitate in boiling water until the washings fail to give a precipitate with chloride of barium,—that is, until it is free from sulphate of soda. Dry the precipitate by the aid of a gentle heat.

On mixing the solutions the usual interchange of acids and bases results, $ZnSO_4 + Na_2CO_3 = Na_2SO_4 + ZnCO_3$, but the carbonate of zinc thus formed begins to evolve carbonic acid as soon as it is precipitated, and when the effervescence is over two of every three molecules are converted into hydrated oxyde :—

$$3ZnCO_3 + 3H_2O = (ZnCO_3,2ZnO,3H_2O) + 2CO_2.$$

Characters and Tests.—White, tasteless, inodorous, insoluble in water, soluble with effervescence and without residue in diluted nitric acid. This solution is not affected by chloride of barium or nitrate of silver (absence of sulphate and chloride), and gives with carbonate of ammonia a white precipitate (oxycarbonate) entirely soluble, without colour (absence of copper), in an excess of the reagent forming a solution which is precipitated white by sulphide of ammonium.

Impurities.—If the sulphate from which it is prepared be impure, the carbonate will probably contain a little chloride and a trace of copper.

Action and Uses.—Similar to those of the oxyde. It is useful as a dusting powder in the intertrigo of infants. Calamina præparata, however, being a more impalpable and cohesive powder, is better adapted for this purpose. It forms with lard a soothing and slightly astringent ointment.

ZINCI SULPHAS, *P.B.* *Sulphate of Zinc.*

$ZnO,SO_3 + 7HO = 80{\cdot}5 + 63$ or $ZnSO_4,7H_2O = 161 + 126$.

Sal Vitrioli. *White Vitriol.* F. *Sulfate de Zinc.* G. *Schwefelsaures Zinkoxyd.*

Contains in 100 parts, ZnO 28, SO_3 28, and H_2O 44.

Preparation.—This salt is prepared in the same way as the chloride, using the same quantity of *granulated zinc*, but substituting 12 fluid ounces of *sulphuric acid* diluted with 4 pints of water, for the hydrochloric acid used in the preparation of the chloride. The iron is also removed by the same process. The filtered solution is then evaporated till a pellicle forms on the surface. The crystals are dried by exposure to the air on filtering paper placed on porous tiles.

In this process the zinc simply displaces the hydrogen of the acid, and combines with the latter, $H_2SO_4 + Zn = ZnSO_4 + H_2$.

Characters and Tests.—Colourless, transparent quadrangular prisms (sometimes 6-sided from truncation of two opposite edges), terminated by 4-sided pyramids, isomorphous with sulphate of magnesia; efflorescent in dry air; soluble in 2½ parts of cold, and less than their own weight of boiling water. When heated the salt melts in its water of crystallisation between 266° and 284°, and six of the seven atoms of water are expelled; at a higher temperature it is decomposed and only oxyde is left. An aqueous solution of the salt gives white precipitates ($BaSO_4$ and ZnS,H_2O respectively), with chloride of barium and sulphide of ammonium. It is not tinged purple (tannate of iron) by tincture of galls; and when acidulated with sulphuric or hydrochloric acid, gives no precipitate with sulphuretted hydrogen (absence of copper, lead, cadmium, and arsenic). After it has been boiled for a few minutes with a little nitric acid (by which sulphate of iron would be peroxydised, see p. 214) it yields with ammonia a white precipitate (hydrated oxycarbonate), which is entirely soluble without colour in an excess of the reagent. (If peroxyde of iron or alumina were present they would remain, see pp. 190, 198, and a trace of copper would give a purple colour to the ammoniacal solution.)

This salt may be obtained crystallised with 1, 2, 5, and 6 atoms of water, according to the temperature at which the crystallisation is effected.

Impurities.—Prepared by the above process, the sulphate is pure; but the commercial salt will give indications of the presence of copper, lead, and iron.

Common white vitriol of commerce may be readily purified by immersing a strip of metallic zinc in the solution. After some time the other metals—copper, iron, arsenic, &c.—are precipitated upon it.

Incompatibilities.—See salts of zinc, p. 223. Alkalies and their carbonates, lime water, salts of barium and lead, ferrocyanide of potassium, astringent vegetables.

Action. Uses.—The astringent and irritant properties of the zinc salts are well illustrated in the sulphate. Small doses are considered sedative. It is chiefly used as an internal remedy in chorea and epilepsy, and as an emetic, the emesis being the result of a local irritant action on the stomach combined with the disagreeable metallic impression left on the palate, which latter is probably the chief excitor of the reflex act. As an emetic it is to be preferred to antimony in cases of poisoning, on account of its stimulant action. To salts of lead and baryta it is antidotal. As an astringent and stimulant injection and lotion, it is an extremely valuable agent, and it may be safely introduced into the bladder or uterus. In cystitis, and when the lochia are unnaturally offensive, these cavities may be freely washed out with a dilute solution (2 grains to 1 fluid ounce of water). Lint moistened with a solution of this strength, and preserved moist by a piece of gutta percha tissue, is the best of all applications to a freely granulating and suppurating ulcer.

Dose.—As a nervine tonic, 1 to 10 grains, twice or thrice a day; as a collyrium, or as an injection in gonorrhœa, 2 grains in an ounce of water; as an emetic, 30 to 60 grains.

ZINCI ACETAS, *P.B.* *Acetate of Zinc.*

$ZnO,C_4H_3O_3+2HO=91{\cdot}5+18$ or $Zn(C_2H_3O_2)_2,2H_2O=183+36$.

Preparation.—Add 2 ounces of *carbonate of zinc* in successive portions to 3 ounces of *acetic acid* mixed with 6 ounces of water in a flask; heat gently, add by degrees 2 ounces more of acetic acid till the carbonate is dissolved; boil for a few minutes, filter while hot, and set aside for two days to crystallise; evaporate the fluid to one-half, and again set aside for two days to crystallise. Drain the crystals in a funnel, and then spread them on filtering paper on a porous tile, and dry them by exposure to the air. In this process the carbonate and hydrate of zinc are decomposed, with the liberation of oxygen and carbonic acid, the former combining with the hydrogen simultaneously displaced from the acetic acid by the zinc.

Characters and Tests.—Thin translucent and colourless crystalline plates of a pearly lustre, with a sharp, unpleasant taste, evolving acetic acid when warmed with sulphuric acid, soluble in water, and the solution precipitated pure white (ZnS) by sulphuretted hydrogen. A dilute watery solution is not affected by chloride of barium or nitrate of silver (no sulphuric acid or chloride), and when slightly acidulated with hydrochloric acid, is not precipitated by sulphuretted hydrogen (absence of lead, cadmium, copper, arsenicum); after it has been boiled for a few minutes with a little nitric acid, it yields with ammonia a white precipitate (ZnO,H_2O) entirely soluble (absence of alumina, magnesia, iron) without colour (absence of copper, see p. 233) in an excess of the reagent.

Action and Uses.—Those of the sulphate, than which it is perhaps slightly more astringent. It may be combined with salts, *e.g.*, acetate of lead, which are incompatible with the sulphate. Internally it is employed as an antispasmodic; externally, in ophthalmia, gonorrhœa, leucorrhœa, and ulceration.

Dose.—1 to 5 grains. As a collyrium or injection, 2 grains to an ounce of water.

ZINCI VALERIANAS, *P.B.* *Valerianate of Zinc.*

$ZnO,C_{10}H_9O_3$ or $Zn(C_5H_9O_2)_2$.

Preparation.—Valerianate of zinc is obtained by the following process: Dissolve 5¾ ounces of *sulphate of zinc* and 5 ounces of *Valerianate of soda*, each in 2 pints of *water;* raise both solutions to near the boiling point, mix them, cool, and skim off the crystals which are formed. Evaporate the mother-liquor at a heat not exceeding 200° to four ounces, cool, and remove the crystals which form, and add them to the former. Drain them on a paper filter, and wash them with a small quantity of distilled water till the washings give with chloride of barium but a very feeble indication of sulphuric acid. Dry at the ordinary temperature of the air. In this reaction the zinc and sodium merely change acids:

$$ZnSO_4 + 2NaC_5H_9O_2 = Zn2C_5H_9O_2 + Na_2SO_4.$$

The zinc salt being the less soluble crystallises first, and is rendered free from adhering sulphate of soda by washing with water, as directed.

Characters and Tests.—In brilliant white pearly tabular crystals, with a feeble odour of valerianic acid, and a metallic taste; scarcely soluble in cold water or in æther; soluble in hot water and alcohol. Heated to redness in an open crucible, it leaves a residue (oxyde of zinc), which when dissolved in diluted sulphuric acid, yields with ammonia a precipitate (hydrated oxyde of zinc) which entirely dissolves in an excess of the reagent, and the resulting solution gives a white (sulphide of zinc) precipitate with sulphide of ammonium. Its solution in hot water is not precipitated by chloride of barium (absence of sulphate). It gives, when heated with dilute sulphuric acid, a distillate, which, when mixed with the solution of acetate of copper, does not immediately affect the transparency of the fluid (as occurs when butyric acid is present), but forms after a short time only drops, which gradually pass into a bluish-white crystalline deposit (valerianate of copper).

The last test is a very necessary one; for Dr Neligan has pointed out that much of the valerianate of zinc of commerce, and especially that prepared in France, consists principally of butyrate of zinc.

Action and Uses.—A nerve tonic and antispasmodic. It is given in hysteria, hysterical epilepsy, and chorea.

Dose.—1 to 3 grains, in the form of pill.

CADMIUM: $Cd=56$ or $\mathbf{Cd}=112$.

A metal of the colour of tin, and so soft as to leave its mark upon paper. Sp. gr. 8·6; fusing point 442°, forming octohedra on cooling. At 176° it becomes so brittle that it may be powdered with facility. It undergoes little change in the air, but burns at a red heat, depositing brownish-yellow fumes of oxyde. It decomposes warm sulphuric and hydrochloric acid with liberation of hydrogen. It was discovered by Stromeyer in 1818, in the ores of zinc. It may be separated from zinc by solution in hydrochloric acid and the addition of excess of carbonate of ammonium, which dissolves the zinc and copper, and leaves the carbonate of cadmium. This is easily reduced by heating with charcoal.

CHARACTER OF SALTS OF CADMIUM.—Colourless; a yellow precipitate ($\mathbf{CdS}$) with sulphuretted hydrogen in acid solutions; a white hydrated oxyde with the *caustic alkalies*, soluble in only one of them viz., ammonia added in excess.

CADMII IODIDUM, *P.B.* $CdI=183$ or $\mathbf{CdI_2}=366$.

Iodide of cadmium may be formed by direct combination of the elements, $\mathbf{Cd}$ 56 parts, and $\mathbf{I}$ 127 parts, in the presence of water.

Characters and Tests.—In flat micaceous crystals, white, of a pearly lustre, melting when heated to about 600°, and forming an amber-coloured fluid. The salt may be crystallised from its solutions in six-sided plates. At a dull red heat violet vapours (of iodine) are evolved. Anhydrous and permanent in the air; freely soluble in water and rectified spirit, and the solution reddens litmus. The aqueous solution gives a yellow precipitate (CdS) with sulphuretted hydrogen or sulphide of ammonium insoluble in excess of the latter; and a white gelatinous precipitate with excess of solution of potash, the filtrate from which is unaffected by sulphide of ammonium (absence of lead and alumina). 10 grains dissolved in water give, with excess of nitrate of silver, a precipitate ($\mathbf{AgI}$), which, when washed with water and afterwards with half an ounce of solution of ammonia (to dissolve any adhering cadmium), and dried, weigh 12·5 grains.

Action and Uses.—Astringent, irritant; reputed to be antisyphilitic. In large doses, emetic; but it is rarely used internally.

1. **Unguentum Cadmii Iodidi,** *P.B.* *Ointment of Iodide of Cadmium.*

Composed of 62 grains of the salt in fine powder, mixed with 1 ounce of simple ointment.

Action and Uses.—Astringent and stimulant. Garrod recommends it in scrofulous swellings and enlarged joints.

CUPRUM, *P.B.* Cu = 31·75 or Cu 63·5.

Venus of the Ancients. F. *Cuivre.* G. *Kupfer.*

Copper is abundantly diffused in nature, being found in the metallic state in cubes, octohedra, or dendritic crystals, as oxyde, sulphide, sulphate, carbonate, arseniate, and phosphate.

It is a reddish metal, of a disagreeable smell when rubbed, and of an unpleasant taste. Sp. gr. 8·95; very ductile and malleable, and possessed of considerable tenacity. It melts at 1996°, and on cooling crystallises. It oxydises slowly in the atmosphere, becoming covered with a green crust of subcarbonate of copper. It decomposes water only at a bright red heat. Its oxygenation is readily effected by nitric acid, and caused even by the weaker acids when exposed to the air, also by alkaline and fatty substances.

Two varieties of copper are prescribed in the Pharmacopœia.

1. Fine Copper Wire, about No. 25, *P.B.*

This is the purest form of copper known in commerce. It is used in the preparation of *Spiritus ætheris nitrosi.*

2. Copper Foil, *P.B.*

Pure metallic copper, thin and bright.

This may be employed to precipitate metals less oxydisable than copper. On immersing a slip of copper foil in acid solutions of the salts of these metals, their acid is set free, and attacks the metallic copper, forming with it a soluble salt, while the metal is deposited upon the surface of the foil. Thus, if a slip of foil be placed in a solution of nitrate of silver, it is soon covered with a frosty-looking coating of metallic silver; if immersed in a solution of chloride of arsenic or antimony, it is immediately covered with a film of metallic arsenic or antimony. Introduced into solutions of mercury, it precipitates the latter in the form of minute globules, which, when rubbed with the finger, form a bright amalgamated surface with the copper.

Pharmaceutical Use.—A test for arsenic in hydrochloric acid.

OXYDES OF COPPER.—There are two salifiable oxydes,—Red or suboxyde (Cu_2O), found native in octohedral crystals; when hydrated ($4Cu_2O,H_2O$), it is of an orange-yellow colour. The protoxide (CuO), or black oxyde of copper, is, as its name indicates, of a black colour, but blue when hydrated (CuO,H_2O). It combines readily with acids, and thus forms the base of the ordinary salts of copper, which are blue or green when hydrated, but white when anhydrous.

CHARACTERS OF THE SALTS OF COPPER.—Green or blue in the crystalline form; a strong metallic taste and astringency; acid reaction on litmus. A steel blade or needle is soon covered with a film of copper when placed in an acid solution of one of its salts. Caustic potash or soda precipitates a pale blue hydrate insoluble in excess (unless organic matters, such as sugar and tartaric acid, be present, when they behave as with ammonia), becoming anhydrous and black on boiling. Ammonia precipitates and dissolves the hydrate, forming a deep blue solution. The alkaline carbonates precipitate a pale blue carbonate, that produced by soda and potash insoluble in excess of these, and converted into black oxyde on boiling; that produced by carbonate ammonia redissolving in excess and forming a deep blue solution. Yellow prussiate of potash causes a rich brown precipitate, soluble in ammonia, but unchanged by it. Sulphuretted hydrogen forms, in acid solutions, a brownish black hydrated sulphide. Copper is distinguished from nickel (which also gives a blue solution with ammonia or its carbonate) by the last two reactions.

CUPRI SULPHAS, *P.B.* *Sulphate of Copper.*

$$CuO,SO_3+5HO=79{\cdot}75+45 \text{ or } CuSO_4,5H_2O=159{\cdot}5+90.$$

Cuprum Vitriolatum. *Blue Copperas* or *Blue Vitriol.* *Blue Stone.*
F. *Sulfate de Cuivre.* G. *Kupfervitriol.*

Contains in 100 parts, CuO 31·85, SO_3 32·07, and H_2O 36·08.

This salt is prepared largely by two methods,—1. By boiling copper in an iron pot with sulphuric acid, diluted with half its bulk of water (see p. 54). The greater part of the sulphurous acid escapes in the gaseous form, a portion, however, reacts on the copper, and forms sulphate and sulphide, $2SO_2+2Cu=CuSO_4+CuS$. 2. By roasting the sulphide thus formed at a moderate temperature, and with free access of air. By this means it is converted into sulphate, which is washed out and crystallised. The salt is in either case purified by resolution and crystallisation.

Character and Tests.—In beautiful clear blue, doubly oblique rhombic prisms (fig. 42). Sp. gr. 2·2; slightly efflorescent in dry air; soluble in four times their weight of cold, and twice their weight of boiling water; insoluble in alcohol. Heated, the crystals melt in their water of crystallisation; at 212° they lose 4 molecules of water, and at 392° the remaining one, and become a greenish white anhydrous powder, which, on combining with water, evolves heat, makes a hissing noise, and becomes blue. At a higher heat sulphuric acid is evolved, and black oxyde of copper remains. An aqueous solution of the salt strongly reddens litmus, gives a white precipitate ($BaSO_4$) with chloride of barium, and a maroon-red precipitate (Cu_2Fcy) with yellow prussiate of potash. If an aqueous solution of the salt be mixed with twice its volume of solution of chlorine (whereby any sulphate of iron would

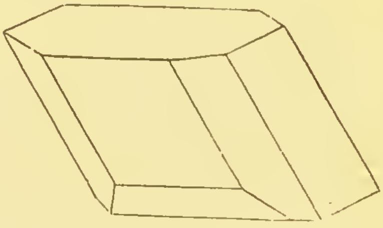

Fig. 42.

be peroxydised), and solution of ammonia be added, the precipitate formed at first will be dissolved by a further and sufficient addition of the alkali, and a violet-blue solution (ammonio-sulphate) will be produced, leaving nothing undissolved (absence of iron, which would remain as peroxyde).

Impurities.—When prepared from roasted copper pyrites (double sulphide of iron and copper, Cu_2S,Fe_2S_3), sulphate of copper will contain a large quantity of sulphate of iron, the cupric and ferrous sulphate crystallising together with 7 instead of 5 atoms of water. An aqueous solution of this mixed salt deposits after a time a rusty flocculent precipitate of hydrated peroxyde of iron, by which the impurity of the salt is manifested.

Incompatibilities.—Alkalies and their carbonates, and salts of the vegetable acids; borax; salts of lime, lead, and silver; astringent vegetable infusions; albumin, grape sugar.

Action and Uses.—The salts of copper, of which the sulphate may be taken as the type, form insoluble, inert compounds with albumin. They are absorbed into the blood, and are slowly eliminated by the skin and kidneys, but chiefly by the intestines. It sometimes produces a blue line, like that of lead, on the margin of the gums, and stains the tartar of the teeth greenish. When the system is saturated with it, the perspiration stains the linen blue. (See Dr Clapton's Observations, *Medical Times and Gazette*, 1868.) According to MM. Bergeron and Id. L'Hôte, copper is constantly found in the parenchymatous organs, even of fœtuses, being imported in the way of alimentation, the use of copper vessels and money, and fixed in the spleen and kidneys, the total mass of which contains about the 0·03 of a grain, and never more than the 0·045 of a grain. Much larger quantities are deposited in these organs during the medicinal use of copper, and retained for some time afterwards. MM. Bournville and Yvon lately brought under the notice of the Académie des Sciences of Paris, February 1875, a case of epilepsy, treated at the Salpêtière. During four months the patient took 43 grammes of ammonio-sulphate of copper, and died three months after the use of the copper was suspended. The liver yielded 295 milligrammes of metallic copper=about 16 grains of sulphate of copper.

In large doses $\frac{1}{4}$ to $\frac{3}{4}$ oz., it is a *violent irritant*, causing persistent vomiting and purging, ending in exhaustion and death. In smaller quantities frequently repeated it produces chronic irritation of the stomach and bowels, marked by anorexia, purging, vomiting, and colicky pains; resulting in emaciation and extreme prostration. Unlike lead, it has no direct or marked action on the nervous system, although it is regarded as a *nervine tonic* and *antispasmodic* in chorea and epilepsy. In vegetable poisoning it is an active and efficient *emetic.* In small doses it is the most valuable *astringent* to the intestinal mucous membrane that we possess, checking intestinal hæmorrhage in enteric fever and dysentery, and controlling the excessive alvine discharges of these diseases. In the solid state it is styptic even to causticity, and is very useful in repressing exuberant granulations and profuse suppuration, and thus promoting cicatrization. It is particularly useful in ulcerations of the mucous membrane. In the form of injection and lotion, it is a powerful astringent in leucorrhœa, gonorrhœa and gleet, otorrhœa, purulent ophthalmia, and flabby ulcerations.

Dose.—$\frac{1}{6}$ to 2 grains as an astringent and nervine tonic; 1 to 2 grains to the ounce as a collyrium and urethral injection; and 2 to 4 grains to the ounce as a lotion.

Antidotes.—White of egg, milk, sugar, tannic acid.

1. **Anhydrous Sulphate of Copper:** CuO,SO_3 or $\mathbf{CuSO_4}$.

Sulphate of copper deprived of its water of crystallisation by a heat of 400°.

Characters.—A yellowish white powder, which becomes blue when moistened with water.

Pharmaceutical Uses.—To indicate the purity of absolute alcohol. If it contain water, the anhydrous sulphate becomes blue when moistened with it.

2. **Cupri Ammonio-sulphas.** *Ammonio-sulphate of Copper.*

Cuprum Ammoniatum. F. *Cuivre Ammoniacal.*

This is a mixture of the double sulphates and carbonates of copper and ammonium, with an excess of carbonate of ammonia, which renders both double salts completely soluble in water. The composition of the salt may be thus represented:—$CuSO_4,(H_4N)_2SO_4,6H_2O+[(H_4N)_2CO_3,4CuOCO_3,CuO,H_2O]+(H_4N)_2CO_3$.

Preparation.—Rub together 1 ounce of *sulphate of copper* and $1\frac{1}{2}$ ounce of *sesquicarbonate of ammonia* till carbonic acid is no longer evolved; then wrap the wet mass in filtering paper, and dry by exposure to the air. Preserve in a well-stoppered bottle.

On comparing the atomic weights of the sulphate and carbonate, it will be seen that a large excess of the latter is employed. On rubbing them together water and carbonic acid escape, and the previously dry powders become wet and pasty, and of a deep blue colour. The compound formed is, as above stated, a mixture of the double sulphates and carbonates of copper and ammonia, with an excess of carbonate of ammonia, which promotes the solubility of the double salts. This will be understood from the following facts. When a solution of potassic sulphate is mixed in proper proportions with one of ammonic sulphate, and the mixture is concentrated, double sulphate of copper and ammonium ($CuSO_4(H_4N)_2,SO_4,6H_2O$) crystallises; and again when solutions of ammonic carbonate and cupric sulphate are mixed together, a bulky, blue precipitate of basic carbonate of copper ($CuCO_3,CuO,2H_2O$) separates. When this is digested in a solution of ammonic carbonate, a double carbonate of ammonia and copper [$(H_4N)_2CO_3,4CuOCO_3,CuO,H_2O$] is formed, and may by spontaneous evaporation of the fluid be separated in deep blue crystals.

Characters.—A beautiful azure-blue powder, cohering in masses having a crystalline structure, a strong ammoniacal odour, and styptic coppery taste. It is wholly soluble in water, forming a deep purple-blue solution, like that of ammonio-sulphate of copper (see below). When exposed to the air ammonia is evolved, and an insoluble basic sulphate of copper is formed. Exposed to a high temperature ammonia is expelled, and black oxyde of copper remains.

Incompatibilities.—Acids, the fixed alkalies, lime water, and metallic salts generally; the reactions being similar to those of the following solution.

Action and Uses.—Those of sulphate of copper. It is less astringent and irritating, and is supposed to be more readily absorbed. It is chiefly employed as a nervine antispasmodic and tonic in epilepsy and chorea.

3. Solution of Ammonio-sulphate of Copper, *P.B.*

Preparation.—Dissolve ½ an ounce of *sulphate of copper* in 8 fluid ounces of water, and add *solution of ammonia* until the precipitate first formed is nearly dissolved. Filter, and then add water to measure 10 fluid ounces.

The bulky, pale blue precipitate formed on the addition of ammonia is the hydrated oxyde of copper, which is dissolved on the addition of an excess of ammonia. To avoid an undue excess, a quantity sufficient to dissolve all but a trace of the oxyde is used. The sulphuric acid is distributed between the copper and ammonium, and the double sulphate (see preceding preparation) is retained in the solution of the hydrated oxyde in free ammonia.

A large excess of ammonia is avoided, because the precipitate, which the solution forms with arsenical salts (arsenite of copper), is soluble in ammonia.

Pharmaceutical Uses.—A test for the presence of sulphur in strong solution of ammonia, black CuS being precipitated when sulphur is present; also for the detection of arsenic and its discrimination from antimony by the production of an emerald-green precipitate of arsenite of copper.

SUBACETATE OF COPPER, *P.B.* *Verdigris.*

$2CuO,C_4H_3O_3+6HO$ or $Cu2C_2H_3O_2,CuO,6H_2O$.

Bibasic Cupric Acetate. *Ærugo.* F. *Vert de Gris.* G. *Grünspan.*

Ærugo or verdigris must have been early known, from the employment of copper vessels. It was employed by the Greeks as a medicine, also by the Arabs, and probably by the Egyptians. There is little doubt, however, that the term Ærugo, as well as the χαλκοῦ ἰός of Hippocrates, included the carbonate as well as this acetate of copper.

Preparation.—Verdigris is made by exposing plates of *copper* to the joint influence of the vapours of *vinegar* or *acetic acid* and the air. The copper rapidly oxydises in the presence of acetous vapours, and these combine with the oxyde as fast as it is formed. The coating of acetate is removed by scraping from time to time. In the south of France sheets of copper are stratified with the refuse of the grape left after making wine, and allowed to remain so for a month or six weeks. Acetous fermentation takes place, and the copper becomes coated with verdigris, which is scraped off, and the operation repeated. The different scrapings form a paste, which is well beaten with wooden mallets, then packed in leathern bags.

Characters and Tests.—Verdigris is sold either in powder or in amorphous masses of a pale bluish green or of a bright blue colour, with an odour of vinegar, and a disagreeable coppery taste. It remains unchanged in the air; but when heated, water is first expelled, and then acetic acid, oxyde of copper being left, with some metallic copper. Verdigris is insoluble in alcohol. It is decomposed by water, being resolved into a soluble *sesquibasic acetate* $3CuO2C_4H_3O_3+6HO$, or $2(Cu2C_2H_3O_2),CuO,6H_2O$, which crystallises on evaporating the solution; and an insoluble tribasic acetate, a dark green crystalline powder $3CuO,C_4H_3O_3+1\frac{1}{2}HO$, or $2[Cu2C_2H_3O_2],4CuO,3H_2O$. Thus: $6(Cu2C_2H_3O_2,CuO)=2[2(Cu2C_2H_3O_2),CuO]+2(Cu2C_2H_3O_2,)4CuO$.

Verdigris is almost entirely soluble in dilute sulphuric acid by the aid of heat. Hydrochloric acid does not leave more than 5 per cent. of impurity. It dissolves in acetic acid, forming a solution of the *normal* or *neutral acetate* (*Verditer*) $CuO,C_4H_3O_3+HO$, or $Cu2C_2H_3O_2,H_2O$.

Action. Uses.—Those of sulphate of copper, than which it is more penetrating. As a mild escharotic, it is applied to warts and venereal ulcers. It is rarely or never used internally.

Dose.—$\frac{1}{6}$ to 6 grains.

Pharmaceutical Uses.—In the preparation of the two following articles:—

1. **Linimentum Æruginis.** *Liniment of Verdigris. Mel Cupri Acetatis. Mel Ægyptiacum.*

This was formerly an article of the Pharmacopœia, but is not contained in the present issue. *

Preparation.—Dissolve 1 ounce of *verdigris* in 7 fluid ounces of *vinegar*. Strain through linen. Add 14 ounces of *clarified honey*, and boil to a proper consistency.

This is a solution of the normal acetate of copper (see above) mixed with oxymel. A minute trace of sulphate of copper is formed by the action of the sulphuric acid of the vinegar. When freshly prepared it has the deep emerald-green colour of solution of the acetate, but by keeping, this colour fades and ultimately disappears, as the copper is gradually precipitated by the reducing action of the grape sugar. In the course of a year or more the decomposition is complete, and the preparation is resolved into a heavy crystalline deposit of suboxyde of copper (Cu_2O) resembling grains of pure bright copper, and a dark brown oxymel free from a trace of copper.

Action and Uses.—Stimulant and slightly escharotic. Applied with a camel's hair brush to ulcerations of the tongue, fauces, and mucous membrane generally.

2. **Solution of Acetate of Copper**, *P.B.*

This is an aqueous solution of the normal acetate, $CuO,C_4H_3O_3+HO$ or $Cu2C_2H_3O_2,H_2O$.

Preparation.—Digest ½ an ounce of the *subacetate of copper of commerce* in 1 fluid ounce of *acetic acid*, diluted with ½ an ounce of *water* at a temperature not exceeding 212°, with repeated stirring, until a dry residue is obtained. Digest this in 4 ounces of boiling *distilled water*, and by the addition of more water make up the solution to 5 fluid ounces. Filter it.

Pharmaceutical Use.—A test for the presence of butyric acid, with which it forms an immediate precipitate of bluish-green sparingly soluble butyrate of copper ($Cu2C_4H_7O_2,H_2O$), (see Valerianate of zinc, p. 230).

LEAD: Pb 103·5 or Pb 207.

Saturn of the Alchemists. F. *Plomb.* G. *Blei.*

Lead is found chiefly as sulphide or *galena*, but occurs in combination with several acids.

It is bluish grey, and when freshly cut is of great brilliancy, but soon tarnishes; has a slight taste, and a peculiar odour when rubbed; is so soft as to mark paper; has little tenacity, but may be beaten into thin sheets. Sp. gr. 11·35. It melts at 617° and boils at a red heat; on solidifying, it contracts, and may be crystallised in cubes or octohedra. Lead is not affected by either hydrochloric or sulphuric acid in the cold, and only slightly when boiled with them. Nitric acid, especially when diluted, attacks it with evolution of nitric oxyde. The vapour of acetic acid also corrodes it. When fused in the air, lead rapidly unites with its oxygen, forms *litharge*, and at a high temperature emits white fumes of oxyde.

Lead may be obtained perfectly pure by reducing the protoxyde (obtained by heating the pure nitrate) or carbonate by means of black flux. It is prepared on the large scale from galena (PbS) by roasting, when sulphate and oxyde of lead are formed. Lime and carbonaceous matters are then added, the former for the purpose of removing sulphuric acid, and the latter to reduce the oxyde of lead to the metallic state.

Impurities.—Commercial lead is sufficiently pure for pharmaceutical purposes, but often contains iron and copper. These may be detected by dissolving the metal in nitric acid and precipitating with a little excess of sulphuric acid. On the addition of ammonia to the filtered solution it becomes blue if copper be present, and precipitates iron in the form of peroxyde. Traces of tin, silver, antimony, and manganese are also occasionally present.

Combined Action of Air and Water on Lead.—Exposed to the air the surface of lead becomes covered with a greyish pellicle. It may be preserved unchanged under perfectly pure water; but if any air be present the lead becomes oxydised, the film of oxyde is dissolved, and the solution absorbs carbonic acid from the air. A film of hydrated basic carbonate of lead ($PbOH_2O,PbCO_3$) forms on the surface of the water, and then falls to the bottom as silky scales, leaving a fresh surface of solution of oxyde to be acted on by carbonic acid and precipitated in the same way, the solution of oxyde going on uninterruptedly if the water be pure, and thus the lead is rapidly corroded. A gallon of water dissolves only about the $\frac{1}{10}$th of a grain of the hydrated basic carbonate of lead at one time, but the presence of small quantities of ammonia, nitrites, nitrates, and chlorides greatly increases this corrosive action. Sulphates and carbonates, on the contrary, diminish it, and a solution of carbonate of lime in carbonic acid causes the deposition of a film of insoluble carbonate of lead upon the metal, which protects it completely from the further action of the water. Hard water (p. 174) always contains these protecting ingredients; but it must be remembered that spring and river water contain both nitrites and nitrates derived from the decomposition of organic matter (pp. 39, 40), and rain water occasionally contains appreciable quantities of ammonia. Further, water highly charged with carbonic acid dissolves carbonate of lead, and may thus remove the protecting covering of the metal and set up the corrosive action to a dangerous extent. The carbonate of lead, however, is like that of lime, deposited on boiling the water. The foregoing facts show that the use of new leaden cisterns is attended with danger until they become coated with a film of carbonate. The action of water on lead, indeed, is so general that traces of the metal are almost always found in water stored in lead. Cisterns of slate or stone should therefore be substituted for the leaden ones in general use.

CHARACTERS OF THE SALTS OF LEAD.—The basic salts have an alkaline, the others an acid reaction; a sweet astringent taste. A white insoluble sulphate with *sulphuric acid* or a soluble *sulphate*, freely soluble in acetate of ammonia, less readily in caustic potash; a black hydrated sulphide (PbS,H_2O) with *sulphuretted hydrogen* or *hydrosulphate of ammonia;* yellow precipitates with *chromate* or *bichromate of potash* ($PbCrO_4$) and with *iodide of potassium* (PbI_2); a crystalline precipitate ($PbCl_2$) with *hydrochloric acid* or a soluble *chloride* freely soluble in caustic potash; a white precipitate of hydrated oxyde ($2PbO,H_2O$) with *caustic potash*, soluble in excess both of potash and soda, but almost insoluble in ammonia. A heavy white carbonate ($PbCO_3$) with carbonate of potash or soda insoluble in excess. All the basic salts of lead are soluble in excess of caustic potash. Lead is readily precipitated from its soluble combinations by the more oxydisable metals; thus a strip of zinc placed in a solution of acetate of lead becomes covered with dendritic crystals of lead.

Action of Lead on the Body.—Lead is slowly absorbed into the system, and remaining there, becomes fixed in the tissues and parenchymatous organs, and in time greatly interferes with their functions. This is especially the case with the nervous system, and results in generally diminished nerve force, first manifested by depression of the motor functions and atrophy of the muscles. The extensors and abductors being the weaker, are the first to suffer; thus wrist drop is one of the earliest indications of lead poisoning. In other cases, the deltoids become atrophied, and the patient is unable to raise the arm from the side. In extreme cases the cerebrum is implicated, the memory is affected, and symptoms of general paralysis creep on. Epileptiform convulsions are occasionally concomitant. The same paralysing effect on the involuntary muscles is very early detected by the enfeeblement of peristaltic action of the intestines, which precedes an attack of painters' colic. The other tissues of the body suffer in an equal degree, the blood is impoverished, and the patient is anæmic and cachectic, neuralgic pains afflict the sensory nerves, the joints become thickened and stiff, and the parenchymatous organs are atrophied and hardened. A blue line along the free margins of the gums indicates this general deposit of lead in the system. It is caused by the formation of black sulphide from the reaction of the free sulphur of the food, or traces of sulphide of hydrogen produced in the mouth, upon the colourless compound of lead in the connective tissue. The soluble salts of lead are astringent in large quantities, mildly irritant, producing severe colic and constipation; in small doses they are reputed to be sedative, but I believe them to be only so as the result of a general depression of nerve force, which appertains to chronic poisoning. The whole of the effects of lead on the body may, I think, be traced to the enfeeblement of the nerve currents, from impairment of the isolating power of the nerve fibres; the presence of lead in the tissues, by increasing their conducting power, tends to cause a lateral diversion of the nerve force, and thus exhausts the currents in their to and fro passage.

OXYDES OF LEAD.—These are—1. *Black suboxyde*, Pb_2, obtained by heating the oxalate in a retort. 2. *Protoxyde* or litharge, PbO (see below). 3. *Peroxyde*, PbO_2, insoluble in acids; it may be prepared by digesting finely levigated red oxyde in boiling nitric acid, diluted with four times its volume of water, and washing the insoluble peroxyde from the nitrate of lead formed by the action of the acid. When heated it loses an atom of oxygen, and is converted into protoxyde. It readily absorbs sulphurous anhydride, and immediately converts it into sulphuric acid, $PbO_2 + SO_2 = PbSO_4$; it may therefore be employed for separating sulphurous acid from admixture with other gases. And 4. *Red oxyde*, red lead or minium,

$2PbO,PbO_2$, a compound of the protoxyde and peroxyde. The red oxyde is obtained by heating the protoxyde below the fusing point, when it absorbs oxygen ($3PbO+O=Pb_3O_4$ or $2PbO,PbO_2$), and the yellow litharge is converted into bright red minium. Three different varieties, however, exist: one is composed of single molecules of the two oxydes, the second has the composition given above, and the third consists of three molecules of protoxyde to one of peroxyde. When heated, oxygen is evolved, owing to the conversion of the peroxyde to protoxyde. When heated with nitric acid a salt of the protoxyde is formed, and a brown peroxyde remains undissolved.

Red lead may be employed for the extemporaneous preparation of chlorine water. This is effected by agitating together 5 parts of red lead, a little less than 3 parts (2·86) of sulphuric acid previously diluted, and mixed with 1 part of common salt. The lead is separated as insoluble sulphate, chlorine is evolved and dissolves in the solution of sulphate of soda simultaneously formed, thus:

$$Pb_3O_4+2NaCl+4H_2SO_4=3PbSO_4+Na_2SO_4+4H_2O+Cl_2.$$

PLUMBI OXYDUM, *P.B.* *Oxyde of Lead.*

$PbO=111{\cdot}5$ or $PbO=223$.

Protoxyde of Lead. Lithargyrum. Litharge. F. *Protoxyde de Plomb.* G. *Bleioxyd.*

Contains in 100 parts, Pb 92·82, O 7·18.

This, the chief salifiable oxyde, was known to the ancients, being easily produced when melted lead continues to be exposed to a current of heated air. The surface of the metal becomes rapidly covered with a scaly powder of a sulphur-yellow colour. This is the protoxyde, and which, being skimmed off, is known in commerce by the name of *massicot.* When the heat is increased to bright red, some metallic lead is separated, the oxyde is fused, though imperfectly, and, on cooling, becomes an aggregated mass, which readily separates into crystalline scales of a greyish red colour. These form the *litharge* of commerce, which varies in colour, and is called *gold litharge* when of a red colour, owing sometimes to the presence of a little red oxyde, but *silver litharge* when lighter coloured. These are frequently obtained in the process of refining gold and silver by means of lead, and in separating the silver from argentiferous lead.

The litharge of commerce is liable to contain a little iron, also copper, carbonate of lead, silica, and other earths.

Characters and Tests.—In heavy (sp. gr. 9·42) scales of a pale brick red colour. It fuses a little above red heat, and in this state combines lime, alumina, and silica, and if melted in earthen crucibles soon dissolves and penetrates them. Litharge decomposes the neutral fats, like the caustic alkalies, forming with them insoluble soaps (see Emplastrum plumbi). It is soluble in lime water and caustic potash and soda. It is deposited from a hot saturated solution in caustic soda (sp. gr. 1·42) in anhydrous crystals of a beautiful rose colour; a cold saturated solution yields, on spontaneous evaporation, transparent, anhydrous dodecahedra. Litharge is soluble in about 15,000 parts of water; the solution has an alkaline reaction, absorbs carbonic acid, and deposits silky crystals of the hydrated basic carbonate, $PbO,H_2O,PbCO_3$. Completely soluble (absence of sulphates of baryta and lead) without effervescence (absence of carbonic acid, which is slowly absorbed by the oxyde when exposed to the air), in dilute nitric and acetic acids, either solution when neutral giving a copious yellow precipitate (PbI_2) with iodide of potassium, and exhibiting the other reactions of a salt of lead (see p. 239). The solution in nitric acid, when supersaturated with ammonia and then cleared by filtration, does not exhibit a blue colour (absence of copper). If sulphate of soda be added to 100 grains of this oxyde, dissolved in dilute nitric acid, 135 grains of sulphate of lead are precipitated.

Action.—(See p. 240.) The poisonous salt derived by the action of water on new leaden pipes or cisterns, or on old ones owing to the presence of nitrates or chlorides, is the hydrated basic carbonate (see p. 239). The same symptoms may arise from inhalation of the dusty particles of the oxyde.

Pharmaceutical Uses.—In the preparation of Plumbi acetas, Liquor plumbi subacetatis, and all the plasters except three, viz., Emplastrum ammoniaci cum hydrargyro, E. cantharidis, and E. picis.

1. **Emplastrum Plumbi**, *P.B. Lead Plaster. Emplastrum Lithargyri. Diachylon Plaster.*

Preparation.—Boil 4 pounds of *oxyde of lead* in fine powder, 1 gallon of *olive oil*, and 3½ pints of *water* together gently by the heat of a steam bath, and keep simmering for four or five hours, stirring constantly until the product acquires a proper consistence for a plaster, adding more water during the process if necessary.

The above process consists in the chemical union of the oxyde of lead with the oil to form an insoluble soap, composed of a mixture of oleate, palmitate, and stearate of lead. Olive oil is composed of three saponifiable or neutral fats—*olein*, *palmitin*, and *stearin;* and each of these is formed by the union of a fatty acid radicle with glycerin ($C_3H_8O_3$), in which it occupies the place of 3 atoms of its hydrogen. Thus olein may be regarded as glycerin, in which 3 equivs. of its hydrogen are replaced by 3 equivs. of the fatty acid radicle ($C_{18}H_{33}O$) of oleic acid ($HC_{18}H_{33}O_2$), thus $C_3H_5(C_{18}H_{33}O)_3O_3$. In the presence of oxyde of lead and water, glycerin and oleic acid are formed; the latter combines with the lead, and the former remains in solution, thus:

$$\underset{\text{Olein.}}{2C_3H_5(C_{18}H_{33}O)_3O_3} + 3PbO + 3H_2O = \underset{\text{Oleate of lead.}}{3(Pb2C_{18}H_{33}O_2)} + \underset{\text{Glycerin.}}{2(C_3H_8O_3)}.$$

As the water is consumed both by decomposition and evaporation, it is necessary to add a little from time to time, so as to maintain it in excess. The reactions of palmitin and stearin, with the oxyde of lead and water, correspond exactly to those of olein. The oleate of lead is soluble in cold anhydrous alcohol and in æther, and may thus be separated from the palmitate and stearate.

Action and Uses.—It does not appear that this compound is absorbed by the healthy or ulcerated skin to which it is applied, for a large surface, such as the leg, may be covered with lead plaster continuously for months or years without any evidence of the absorption of lead. On account of its adhesiveness, smoothness, and complete freedom from irritating properties, it forms, when spread on calico, an excellent strapping to parts requiring support, and is employed for keeping the surfaces of wounds in contact.

Pharmaceutical Uses.—Lead plaster forms the basis of the following:—Emplastrum resinæ, E. saponis, E. calefaciens, E. galbani, E. ferri, and E. hydrargyi.

2. **Emplastrum Resinæ**, *P.B.* *Resin Plaster. Emp. adhæsivum. Sticking Plaster. Basilicon Plaster.*

This is lead plaster, with the addition of a little resin ($\frac{1}{9}$th) and soap ($\frac{1}{18}$).

Preparation.—Melt 2 pounds of *plaster of lead* with a gentle heat, add 4 ounces of *resin* and 2 ounces of *hard soap*, also melted, and mix.

Action. Uses.—This plaster, serving the same purposes as lead plaster, is more frequently employed on account of being more adhesive; but is objectionable in some cases, in consequence of the irritant action of the resin.

Pharmaceutical Uses.—Resin plaster is the basis of the following:—Emplastrum belladonna, E. calefaciens, E. opii, and E. plumbi iodidi.

3. **Emplastrum Saponis**, *P.B.* *Soap Plaster.*

Preparation.—To 2¼ pounds of *lead plaster*, melted by a gentle heat, add 6 ounces of *hard soap* and 1 ounce of *resin* previously melted, and thoroughly mix them.

Action and Use.—Less stimulant and adhesive than resin plaster, it is better adapted for protecting tender or abraded surfaces. It softens the cuticle, and is therefore a good application to corns.

Pharmaceutical Uses.—It is a basis of Emplastrum calefaciens and E. plumbi iodidi.

4. **Emplastrum Cerati Saponis**, *P.B.* *Soap Cerate Plaster.*

This is a mixture of lead, soap, and the acetates of lead and soda.

Preparation.—Boil together 1 gallon of *vinegar* and 15 ounces of *oxyde of lead*, by the aid of a steam bath, constantly stirring until the oxyde has combined with the acid; then add 10 ounces of *hard soap*, and boil again until most of the moisture is evaporated; finally, add 12½ ounces of *yellow wax* melted with 1 pint of *olive oil*, and stir the whole continuously, maintaining the heat until by the evaporation of the remaining moisture the product has acquired the proper consistence for a plaster.

In this process a solution of normal acetate of lead is formed, 1 gallon of vinegar = 7·36 ounces of acetic anhydride, the equivalent of 15 ounces of oxyde of lead. This solution is partly decomposed by the soap, oleate and stearate of lead, and acetate of soda being formed.

Action and Uses.—A soothing plaster, less irritant than 2 and 3, and more astringent than lead plaster.

PLUMBI IODIDUM, *P.B.* *Iodide of Lead.*

$PbI = 230{\cdot}5$ or $PbI_2 = 461$.

F. *Iodure de Plomb.* G. *Iod-Blei.*

This salt may be formed by the direct action of iodine and lead, or as follows:—

Preparation.—Dissolve 4 ounces of *nitrate of lead* by the aid of heat in 1½ pint of *water*, and 4 ounces of *iodide of potassium* in half a pint of water, and mix the solutions. Collect the precipitate on a filter, wash it with water (from the nitrate of potash), and dry at a gentle heat. The iodine and nitrion merely change places, $Pb(NO_3)_2 + 2KI = PbI_2 + 2KNO_3$.

Characters and Tests.—A bright yellow powder, tasteless and odourless. Sp. gr. 6·384. Sparingly soluble in cold water; entirely soluble in boiling water, from which it is deposited, on cooling, in silky yellow scales. It is soluble in acetic acid, alcohol, solution of potash, and solutions of the alkaline iodides, with which it forms double salts. It may be fused by a moderate heat, but at a high temperature it is partly sublimed and partly decomposed with the evolution of violet vapours. If 100 grains be dissolved in nitric acid, diluted with twice its weight of boiling water, and after the iodine is expelled, sulphate of soda be added, 66 grains of sulphate of lead are thrown down.

Uses.—This preparation is an encumbrance to the Pharmacopœia, being unfit for internal use and useless as an external application. As an "alterative" it is supposed to act beneficially when applied in the form of ointment or plaster to cancerous sores and scrofulous joints. It is employed in the next two preparations, in both of which it exists in the proportion of 1 part in 9.

Dose.—¼ to 2 grains.

1. **Unguentum Plumbi Iodidi**, *P.B.* *Ointment of Iodide of Lead.*

Composed of 62 grains of the iodide, mixed with 1 ounce of simple ointment.

2. **Emplastrum Plumbi Iodidi**, *P.B.* *Plaster of Iodide of Lead.*

Preparation.—Melt together 4 ounces each of *soap and resin plasters*, add 1 ounce of *iodide of lead* in fine powder, and mix intimately.

Action.—Discutient in chronic enlargements of the joints and in scrofulous tumours.

PLUMBI CARBONAS, *P.B.* *Carbonate of Lead.*

$2(PbO,CO_2)+HO,PbO$ or $2PbCO_3,PbO,H_2O$.

Cerussa. White Lead. F. *Carbonate de Plomb.* G. *Kohlensaures Bleioxyd. Bleiweiss.*

Carbonate of lead has been known from the highest antiquity. It is found as a mineral in many lead districts, and known as *cerusse* and *white lead ore.*

Preparation.—The most ancient method, and that which makes the best white lead for the use of painters, is by exposing thin sheets of lead to the combined action of air, the vapour of acetic acid, and carbonic acid. A number of small earthen pots (fig. 43), each containing a little weak vinegar (C, fig. 44) in the lower part, and a coil of the sheet lead (P, P, fig. 44) suspended above it, are arranged side by side, and imbedded in a mixture of new and spent tan. The tan gradually heats or ferments, and begins to exhale carbonic anhydride, the temperature of the inner parts of the stack rising to 140° or 150°, or even higher. The acetic acid is slowly volatilised, and its vapour passing readily through the gratings or folds of the lead, combines with the oxyde formed on the surface of the metal, converting it into basic acetate ($Pb2C_2H_3O_2,2PbO$), and this, by the action of $2CO_2$, is decomposed into ordinary acetate ($Pb2C_2H_3O_2$) and carbonate of lead ($2PbCO_3$). The ordinary or normal acetate combines with a fresh portion of the oxyde, and is thus reconverted into the basic acetate, which is again reduced into the normal state by the action of fresh carbonic acid; and thus a round of changes is continued by the agency of a small quantity of acetic acid, one part of which is sufficient to convert 100 parts of lead into carbonate. The process is a slow one, and as soon as a thick incrustation has formed, it is detached, crushed, and transferred to mills, where it is ground with water into a thin paste, and when washed and dried constitutes the white lead of commerce. It always contains an excess of oxyde, but the quantity is liable to variation.

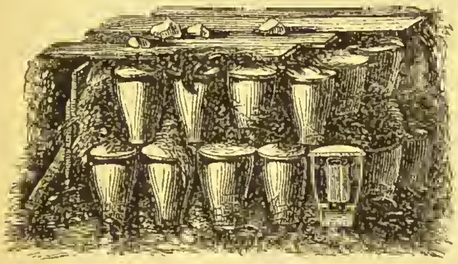

Fig. 43.

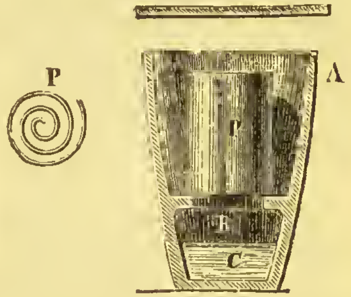

Fig. 44.

Characters and Tests.—A soft, heavy, dead-white powder, blackened (PbS) by sulphuretted hydrogen, insoluble in water, soluble with effervescence in dilute acetic acid without leaving any residue (absence of sulphates), and forming a solution which is precipitated white ($PbSO_4$) by sulphuric acid, and yellow (PbI_2) by iodide of potassium. The acetic solution when treated with excess of sulphuretted hydrogen, boiled, and filtered, gives no precipitate with oxalate of ammonia (absence of lime).

Impurities.—Carbonate and sulphate of lime, sulphate of baryta, which are detected by the above tests.

Action.—(See p. 240.) This salt is the most frequent source of lead poisoning, and those who are engaged in its manufacture and in its use as a pigment are the frequent victims of its deleterious action. The lead gains access to the system by the lungs, fine particles of the carbonate being carried there in the process of inspiration.

Use.—Medicinally it is used externally as a desiccant and astringent to excoriated surfaces. Although we can adduce no positive proof of its absorption by the skin, it would be well if this preparation of lead were entirely excluded from the Pharmacopœia; for it has no advantage, even as a desiccant and astringent, over harmless oxyde or carbonate of zinc.

1. **Unguentum Plumbi Carbonatis**, *P.B.* *Ointment of Carbonate of Lead.*

Prepared by mixing thoroughly 62 grains of *carbonate of lead* in fine powder with 1 ounce of *simple ointment.*

Action and Uses.—A cooling and drying application to excoriations and irritable eruptions and ulcerations.

PLUMBI NITRAS, *P.B.* *Nitrate of Lead.*

$PbO,NO_5 = 165{\cdot}5$ or $Pb2NO_3 = 331$.

Contains in 100 parts, PbO 67·22 and N_2O_5 32·78.

There are several nitrates of lead. This, the normal one, is readily prepared by dissolving litharge (4½ ounces) in an excess of dilute nitric acid (1 pint) by the aid of a gentle heat, filtering, and crystallising.

Characters and Tests.—In colourless regular octohedra, more or less milk white and opaque, permanent in the air, of a sweetish astringent taste, soluble in about 8 parts of cold water, sparingly soluble in nitric acid, insoluble in alcohol. The aqueous solution is precipitated black (PbS) by sulphuretted hydrogen; white ($PbSO_4$) by dilute sulphuric acid, and yellow (PbI_2) by iodide of potassium. Added to sulphate of indigo, it discharges the colour. Heated to redness, the salt decrepitates, fuses, parts with oxygen and peroxyde of nitrogen (NO_2); and protoxyde of lead remains.

Action.—That of the other preparations of lead. It is contained in Ledoyen's *Disinfecting solution.*

Pharmaceutical Use.—In the preparation of Plumbi iodidi.

PLUMBI ACETAS, *P.B.* *Acetate of Lead.*

$PbO,C_4H_3O_3,3HO = 162{\cdot}5 + 27$ or $Pb2C_2H_3O_2,3H_2O = 325 + 54$.

Sugar of Lead. *Saccharum saturni.* F. *Acetate de Plomb.*
G. *Bleizucker.*

Contains in 100 parts, PbO 58·9, $C_4H_6O_3$ 26·8, and H_2O 14·3.

Acetic acid combines with lead to form four distinct acetates; the salt under consideration is the normal acetate. It is prepared by dissolving litharge in acetic acid.

Preparation.—Dilute 2 pints of *acetic acid* with 1 pint of *water;* add 24 ounces of *oxyde of lead* in fine powder, and dissolve with the aid of a gentle heat. Filter, evaporate, until a pellicle forms; secure, if need be, a distinctly acid reaction by the addition of a little *acetic acid,* and set aside to crystallise. Drain and dry the crystals on filtering paper without heat. The combination of the oxyde and acid results, as usual, in the liberation of water, $2HC_2H_3O_2 + PbO = Pb2C_2H_3O_2 + H_2O$. A slight excess of *acetic acid* is added, to prevent the formation of basic acetate, which has an alkaline reaction.

Characters and Tests.—In white crystalline masses, composed of brilliant but minute right-rhombic prisms, terminated by dihedral summits (fig. 45), usually somewhat opaque, slightly efflorescent, having an acetous odour, and a sweet astringent taste. Soluble in less than twice its weight of water (absence of sulphate), and also freely soluble in alcohol. The aqueous solution slightly reddens litmus, dissolves oxyde of lead (forming basic acetate), gives a yellow precipitate (PbI_2) with iodide of potassium, and is precipitated white ($PbSO_4$) by sulphuric acid, acetic acid being set free (see Acetates). Its solution in pure water is clear, or has only a slight milkiness (a trace of carbonate, from carbonic acid in the water), which disappears on the addition of acetic acid. 38 grains dissolved in water require for complete precipitation 200 gr. measures of the volumetric solution of oxalic acid (proving the proper proportion of lead for the normal acetate). When the salt is heated it becomes anhydrous, and then fuses to a clear liquid. On raising the heat acetone (C_3H_6O) and carbonic acid are evolved, and the residue forms a crystalline mass of the sesquibasic plumbic acetate. At a higher temperature this is completely decomposed, leaving a pyrophoric mixture of lead and carbon. Acetate of lead is generally pure.

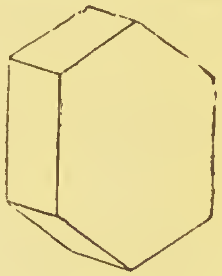
Fig. 45.

Incompatibilities.—The vegetable (acetic excepted) and mineral acids. Carbonic acid precipitates a portion of the lead as carbonate; but the liberated acetic acid prevents further decomposition. Sulphuric and hydrochloric acid, and the soluble sulphates and chlorides throw down the lead as insoluble sulphate or chloride.

Infusum rosæ acidum, akalies (see salts of lead, p. 239), borax, lime water. Astringent vegetable infusions, which precipitate the lead as insoluble gallo-tannate. Opium, which precipitates meconate of lead. Hard water.

Action and Uses.—The acetate fully represents the astringent quality of a soluble salt of lead. It may also be regarded as a sedative, in the same sense as salts of zinc, by relieving excessive vascularity of the parts with which it comes in contact (see p. 224). The internal use of the acetate should not be long continued. Pereira states that he has observed a distinct blue line on the gums after the ingestion of 5 grains thrice a-day for a fortnight. It is a very useful astringent in active or passive hæmorrhages from the mucous membrane; but copper should be preferred in intestinal hæmorrhage when it can be tolerated. The lead salt is the preferable in hæmoptysis. As an injection it is valuable in dysentery; as a collyrium and wash to ulcers, it is superseded by the solution of subacetate. The use of either is contraindicated in ulceration of the cornea, on account of the liability to the formation of an insoluble opaque compound with the albuminous matter of the transparent structure.

Dose.—1 to 5 grains twice or thrice a day, given with dilute acetic acid or oxymel; as a lotion or injection, 5 grains in 1 ounce of water; and as a collyrium, 2 to 4 grains in the ounce.

Antidotes.—Large draughts of solution of sulphate of soda or magnesia, followed by evacuation of the stomach. Insoluble sulphate of lead is thus formed.

Pharmaceutical Uses.—In the preparation of the following four articles:—

1. **Pilula Plumbi cum Opio**, *P.B.* *Pill of Lead and Opium.*

8 grains contain 6 grains of the acetate and 1 grain of opium.

Preparation.—Mix together 36 grains of *acetate of lead* in fine powder, and 6 grains each of *powdered opium* and *confection of roses*, and beat into an uniform mass.

A small quantity of the acetate is decomposed by the meconic acid of the opium and the gallo-tannic acid of the confection, forming insoluble meconate and gallo-tannate of lead.

Action and Uses.—An astringent sedative, employed for the arrest of hæmorrhage and excessive alvine discharges, as occurs in enteric fever and chronic dysentery and diarrhœa.

2. **Unguentum Plumbi Acetatis**, *P.B.* *Ointment of Acetate of Lead.*

Composed of 12 grains of finely powdered *acetate of lead*, thoroughly mixed with 1 ounce of *benzoated lard*..

Uses.—As a cooling application to burns, blisters, and irritable sores.

3. **Suppositoria Plumbi Composita**, *P.B.* *Compound Lead Suppositories.*

Preparation.—Melt together 10 grains of *white wax* and 80 grains of *oil of theobroma* with a gentle heat, then add 36 grains of *acetate of lead*, 12 grains of *opium* in powder, and 42 grains of *benzoated lard* previously rubbed together in a mortar, and having mixed them thoroughly, pour the mixture while it is fluid into suitable moulds of the capacity of fifteen grains; or the fluid mixture may be allowed to cool, and then be divided into twelve equal parts, each of which shall be made into a conical or other convenient form for a suppository.

Useful in piles, chronic dysentery, bleeding, and relaxed condition of the lower bowel.

LIQUOR PLUMBI SUBACETATIS, *P.B.*

Solution of Subacetate of Lead. F. *Sous-acetate de Plom.* G. *Halb-Essigsaures Bleioxyd.*

Subacetate of lead, $2PbOC_4H_3O_3$ or $PbC_2H_3O_2$, dissolved in water.

This solution is commonly called *Goulard's Extract* or *Extract of Saturn*—that is, lead. It seems to have been known since the time of Basil Valentine.

Preparation.—Boil 5 ounces of *acetate of lead* and 3½ ounces of *oxyde of lead* in powder in 1 pint of *water* for half an hour, constantly stirring, then filter, and when cold add more water to make the product measure 10 fluid ounces. Preserve in stoppered bottles.

In this process the oxyde of lead is dissolved by the normal acetate forming a solution of the basic acetates, chiefly tribasic acetate $(Pb2C_2O_3O_2,2PbO,H_2O)$. The formula of the Pharmacopœia is that of a monobasic acetate, and implies that the normal acetate simply combines with another equivalent of oxyde.

Character and Tests.—A dense, clear, colourless liquid; sp. gr. 1·26; of alkaline reaction, and sweet astringent taste, becoming turbid by exposure to the air (deposition of carbonate from absorption of carbonic acid), and forming with mucilage of gum arabic an opaque white jelly. Sulphuric acid in excess gives a white precipitate $(PbSO_4)$, acetic acid being set free. 413·3 grains (6 fluid drachms) require for perfect precipitation 810 gr. measures of the volumetric solution of oxalic acid (proving the proper proportion of lead).

Action and Uses.—Astringent and soothing as an external application diluted with water, as an adjunct to refrigerating spirituous lotions, or liniments in combination with fatty matters.

Incompatibilities.—Those of the normal acetate (see p. 247). Mucilaginous solutions and drinks, spring or river water.

Pharmaceutical Uses.—The preparation of the weaker solution, and Unguentum plumbi subacetatis compositum.

1. **Liquor Plumbi Subacetatis dilutus,** *P.B.* *Diluted Solution of Subacetate of Lead. Goulard Water.*

10 fluid ounces contain 1 fluid drachm of the Liquor plumbi subacetatis.

Prepared by mixing 2 fluid drachms each of *solution of subacetate of lead* and *rectified spirit* with 19½ fluid ounces of *water*. Filter, and keep the solution in a well-stoppered bottle.

The small quantity of carbonic acid contained in distilled water is sufficient to render the solution a little milky, hence it is necessary to filter it, and to prevent further absorption of the gas to preserve it in well-closed bottles. Common water renders the solution very turbid from the deposition of insoluble carbonate, sulphate, and chloride of lead. The small quantity of spirit serves no purpose, and has no significance.

Uses.—A soothing wash to a cracked and irritable skin, as in eczema, intertrigo in combination with oil. Soft linen, or spongiopiline, may be saturated with the warm solution and worn as a poultice.

2. **Unguentum Plumbi Subacetatis Compositum**, *P.B.* *Compound Ointment or Cerate of Subacetate of Lead. Goulard's Cerate.*

Preparation.—Melt 8 ounces of *white wax* with 16 ounces of *almond oil* by the heat of a water bath, and allow it to cool until it begins to thicken, then gradually add 6 fluid ounces of *solution of subacetate of lead*, and stir the mixture constantly while it cools, then add 60 grains of *camphor* dissolved in 4 ounces of *almond oil*, and mix thoroughly.

Action and Uses.—An astringent, and slightly stimulant application.

BISMUTH: Bi = 210 or **Bi** = 210.

Bismuthum. F. *Bismuth.* G. *Wismuth.*

This metal is first mentioned by Agricola in 1520, having previously been confounded with lead. It is usually met with in its metallic state, but also as sesquioxyde and sesquisulphide.

Bismuth is hard and brittle, of a lamellar structure, and readily crystallises in cubes or octohedra. It melts at 507°, and volatilises at a full red heat. When exposed to the air it tarnishes, but does not oxydate; at a red heat burns with a pale blue flame, evolving white fumes of bismuth sesquioxyde, $\mathbf{Bi_2O_3} = 468$. Bismuth is with difficulty acted on by hydrochloric acid. Boiling sulphuric acid oxydises it, but this is much more readily effected by nitric acid. It combines directly with sulphur, chlorine, bromine, and iodine.

Commercial bismuth is never pure, but contains silver, lead, iron, and very frequently sulphur and arsenic. The two impurities last mentioned are removed by the following process:—

Bismuthum Purificatum, *P.B.* *Purified Bismuth.*

Preparation.—Put 10 ounces of *bismuth* and 1 ounce of *nitrate of potash* into a crucible, and heat them to a temperature at which both the metal and the salt are fused. Continue the heat, constantly stirring the contents of the crucible for fifteen minutes, or until the salt has solidified into a slag over the metal. Then remove the salt, add 1 ounce more of nitrate of potash to the bismuth in the crucible, and repeat the process as before. Finally, pour the bismuth while fused into a suitable mould, and allow it to cool.

Sulphur and arsenic present in the impure metal are oxydised by the nitre, and removed with it.

The bismuth still retains the other metallic impurities mentioned above, and these may be removed by solution of the metal in nitric acid, pouring the saturated solution into a large body of water, washing, drying, and reducing the basic nitrate thus obtained by means of charcoal. The metal is really subjected to this second purification in the preparation of the salts used in medicine.

Characters and Tests.—A crystalline metal of a greyish-white colour, and distinct roseate tinge; sp. gr. 9·83; dissolved in a mixture of equal volumes of nitric acid and water, it forms a solution which by evaporation yields colourless crystals (of normal nitrate, $Bi3NO_3,5H_2O = 396 + 90$), that are decomposed on the addition of water, giving a white precipitate (of subnitrate, $Bi_2O_32HNO_3$). If the mother-liquor from which the crystals have been separated be added to solution of carbonate of ammonia, the precipitate formed, and the solution is free, or nearly free from colour (proving the absence or the presence of only a trace of copper, which would give a blue colour to the solution; and of iron and silver, which would give a brown colour to the precipitate).

BISMUTHI OXYDUM, *P.B.* *Oxyde of Bismuth.*

$BiO_3 = 234$ or $Bi_2O_3 = 468$.

Contains in 100 parts, Bi 89·74 and O 10·26.

This is the principal oxyde of bismuth. It was formerly called teroxyde, and is now indifferently called oxyde or sesquioxyde.

Preparation.—Boil together 1 pound of *subnitrate of bismuth* and 4 pints of *solution of soda* for five minutes. When the mixture is cool, and after the oxyde has subsided, decant the supernatant liquid, wash the precipitate thoroughly with water, and finally dry the oxyde by the heat of a water bath.

In this process the sodium abstracts the whole of the nitric acid from the bismuth subnitrate, leaving it in the state of sesquioxyde, water being formed simultaneously:—$Bi_2O_32HNO_3 + 2NaHO = 2NaNO_3 + 2H_2O + Bi_2O_3$.

The excess of caustic soda used is necessary for the complete removal of the nitric acid, but if a trace of plumbic oxyde should happen to be present (which, however, is not probable, see above), it would dissolve it, and thus separate it from the bismuth oxyde. The nitrate of soda is removed by the washing.

Characters and Tests.—A dull, lemon-yellow powder. Heated to incipient redness, it is not diminished in weight (being anhydrous—the hydrate, Bi_2O_3,H_2O, is formed when the oxyde is prepared by precipitating the nitrate by ammonia). Insoluble in water, but soluble in nitric acid mixed with half its volume of water (forming a solution of normal nitrate); and if it be thus dissolved to saturation, the solution mixed with ten or twenty times its volume of water, yields a white precipitate (subnitrate, which see). The nitric acid solution gives no precipitate with diluted sulphuric acid (absence of lead), nor with solution of nitrate of silver (absence of chloride). Solution of chloride of ammonium, added to the nitric acid solution, gives a white precipitate (of bismuth oxychloride or *pearl-white*, $2(BiCl_3,Bi_2O_3),H_2O$, insoluble in ammonia); and if this be treated with excess of solution of ammonia then filtered, and the clear filtrate neutralised with hydrochloric acid, it will not become turbid (absence of silver, which, if present, would be thrown down as chloride, dissolved in the ammonia and reprecipitated on neutralisation of the ammoniacal solution).

Action and Uses.—Those of the subnitrate for which it may be substituted.

Dose.—5 to 15 grains.

BISMUTHI SUBNITRAS, *P.B.* *Subnitrate of Bismuth.*

BiO_3,NO_5,HO or $Bi_2O_3,2HNO_3$.

Bismuthum Album. Trisnitrate of Bismuth. Magistery of Bismuth. F. *Sousnitrate de Bismuth.* G. *Wismuth weiss.*

Preparation.—Dilute 4 ounces of *nitric acid* with 3 ounces of *water*, and add 2 ounces of *bismuth* in coarse powder in successive portions. When effervescence has ceased, apply for ten minutes a heat approaching that of ebullition, and decant the solution from any particles of metal which may remain undissolved. Evaporate the solution till it is reduced to 2 fluid ounces, and pour it into half a gallon of *water*. When the precipitate which forms has subsided, decant the supernatant liquid, and agitate the sediment with another half gallon of water. After two hours, again decant, and having drained the product on a filter, dry it at a temperature not exceeding 150°.

By solution of the metal in nitric acid the normal or trisnitrate of bismuth is obtained with the evolution of nitric oxyde, and the formation of water: $2Bi + 8HNO_3 = 2(Bi3NO_3) + 2NO + 4H_2O$. When the solution of this salt is poured into the large quantity of water, it is decomposed, a subnitrate separates, and normal nitrate remains in solution with excess of nitric acid, thus: $3(Bi3NO_3) + 3H_2O = (Bi_2O_32HNO_3) + Bi3NO_3 + 4HNO_3$.

Characters and Tests.—A white tasteless powder, in minute crystalline scales. It is blackened by sulphuretted hydrogen (Bi_2S_3); is insoluble in water, but soluble in nitric acid mixed with half its volume of water, forming a solution which poured into water gives a white precipitate (subnitrate). It forms with sulphuric acid diluted with an equal bulk of water a solution which is blackened by sulphate of iron (indicating the presence of nitric acid, see p. 73). The nitric acid solution gives no precipitate with diluted sulphuric acid (absence of lead and baryta) nor with solution of nitrate of silver (absence of chlorine or chloride).

Impurities.—The most serious impurity in nitrate bismuth is *arsenic*, arising from the use of commercial bismuth. This has proved a serious source of error in medico-legal inquiries. Dr Herapath has discovered in some specimens of this preparation 1 grain of arsenic in 1000, in others as much as 1 in 433. He states that it is not all removed by fusing with nitre, as prescribed in the Pharmacopœia, and he proposes to boil the nitrate in solution of a caustic alkali, which removes the arsenic, and converts the bismuth into the insoluble oxyde. The impurity is readily detected by Marsh's test (see p. 290).

Adulterations.—Carbonate of lead, carbonate, and phosphate of lime. The carbonates are detected by solution with effervescence (CO_2) in dilute nitric acid, and if lead be present the addition of sulphuric acid gives a white precipitate ($PbSO_4$). The lime and phosphoric acid may be detected in the acid solution after precipitation of the bismuth by sulphuretted hydrogen.

The *oxychloride* and the *carbonate* of bismuth are sometimes substituted for the nitrate, or mixed with it. The *oxychloride* is used to make enamel, as a cosmetic, and for white sealing-wax. It is obtained when aqua regia is used instead of nitric acid in the above process. It is more apt to contain arsenic than the nitrate.

Action. Uses.—Nitrate of bismuth appears to be insoluble in the animal juices. It has not been proved that it ever undergoes absorption or passes into the fluids of the body. It may be given in very large doses without ill effect. But is often of considerable use in gastrodynia and chronic vomiting, caused by irritable conditions of the mucous membrane of the stomach, and it has been used with advantage in diarrhœa depending on a similar derangement of the intestines. It is especially useful in the functional vomiting of phthisis and pregnancy. Dr Headland conceives that it may operate in these cases by simply cloaking some of the delicate or irritable portions of the mucous surface with an insoluble white covering.

It is used as a cosmetic in the form of powders, or mixed with simple ointment or glycerin.

Dose.—5 to 20 grains, in almond mixture, mucilage, or milk, or as lozenge.

1. Trochisci Bismuthi, *P.B.* *Bismuth Lozenges.*

Each contains 2 grains of the subnitrate.

Preparation.—Mix together 1440 grains of *subnitrate of bismuth*, 4 ounces of *carbonate of magnesia*, 6 ounces of *precipitated carbonate of lime*, 29 ounces of *refined sugar*, and 1 ounce of *gum acacia* in powder. Then add 2 fluid ounces of *mucilage of gum acacia*, and form the whole into a proper mass with rose water. Divide into 720 lozenges, and dry them at a moderate heat.

Dose.—2 to 10 of the lozenges.

BISMUTHI CARBONAS, *P.B.* *Carbonate of Bismuth.*

$2(BiO_3,CO_2),HO$ or $2(Bi_2CO_5),H_2O$.

This is really a subcarbonate. It was first introduced by Dr Hannon of Brussels, who used it in the same cases as the subnitrate, but regarded it as a more efficient preparation.

Preparation.—Make *a solution of bismuth in nitric acid* in the manner directed and in the same quantities as prescribed for the subnitrate, and concentrate it in like manner to 2 fluid ounces; add this in small quantities at a time to a cold filtered solution of 6 ounces of *carbonate of ammonia* in 2 pints of *water*, constantly stirring the precipitate as it is formed. Collect it on a calico filter, and wash it with distilled water until the washings pass tasteless. Remove now as much of the adhering water as can be separated from the precipitate by slight pressure with the hands, and finally dry the product at a temperature not exceeding 150°.

The solution of trisnitrate is decomposed by the carbonate of ammonia with effervescence of carbonic acid, nitrate of ammonia remains in the solution, and subcarbonate of bismuth is precipitated thus:—

$$2(Bi3NO_3)+3[(H_4N)_2CO_3]=2CO_2+6H_4N,NO_3+Bi_2CO_5.$$

A high temperature must be avoided in drying the carbonate, otherwise carbonic anhydride is expelled.

Characters and Tests.—A white powder, blackened by sulphuretted hydrogen (Bi_2S_3); insoluble in water, but soluble with effervescence (CO_2) in nitric acid. When added to sulphuric acid coloured with sulphate of indigo, the colour of the latter is not discharged (absence of nitrate). If to nitric acid mixed with half its volume of water as much carbonate of bismuth be added as the acid will dissolve, 1 volume of this solution poured into 20 volumes of water will yield a white precipitate (indicating the presence of a salt of bismuth). The nitric acid solution gives no precipitate with dilute sulphuric acid (absence of lead and baryta) or with solution of nitrate of silver.

Action and Uses.—Those of the subnitrate, but on account of its antacid properties it is more serviceable in acid dyspepsia.

Dose.—5 to 20 grains.

LIQUOR BISMUTHI ET AMMONIÆ CITRATIS, *P.B.*

Solution of Citrate of Bismuth and Ammonia.

A solution of oxyde of bismuth in solution of citrate of ammonia, containing nitrate of ammonia. 1 fluid drachm contains 3 grains of Bi_2O_3.

Preparation.—Dilute 2 fluid ounces of *nitric acid* with 1 ounce of *water*, and add 430 grains of *purified bismuth* in successive portions. When effervescence has ceased, apply for ten minutes a heat approaching that of ebullition, and decant the solution from any insoluble matter that may be present. Evaporate the solution until it is reduced to 2 fluid ounces, then add 2 ounces of *citric acid* previously dissolved in 4 ounces of *water*, and afterwards *solution of ammonia* in small quantities at a time until the precipitate formed is redissolved, and the solution is neutral or slightly alkaline to test-paper. Dilute with water to measure 1 pint.

A solution of nitrate is formed as in the preceding preparations, and this is unaffected by the addition of citric acid. On adding to the mixture ammonia, oxyde of bismuth is precipitated, and nitrate of ammonia is formed: $2(Bi3NO_3)+3(H_4N)_2O=6H_4N,NO_3+Bi_2O_3$. Citrate of ammonia is subsequently formed, and in this the oxyde is dissolved.

Characters and Tests.—A colourless solution, with a saline and slightly metallic taste; sp. gr. 1·122. Neutral or slightly alkaline to test-paper; mixes with water without change; heated with solution of potash, it evolves ammonia and yields a white precipitate (citrate of potash being formed and the oxyde of bismuth precipitated). Hydrochloric acid added to it gives a white precipitate (Bi_2O_3), which is soluble in excess of the reagent. Three fluid drachms of the solution, mixed with an ounce of water and treated with sulphuretted hydrogen in excess, yields a black precipitate (Bi_2S_3), which collected, washed, and dried, weighs 9·92 grains (proving the proper proportion of bismuth).

One fluid drachm contains 3 grains of oxyde of bismuth.

Action. Uses.—Those of the subnitrate and the carbonate, but it may often be conveniently substituted for these heavy insoluble powders. As both acids and alkalies decompose it, it can hardly pass unchanged into the blood. Its action, as that of the others, is probably local.

Dose.—30 to 60 grains.

TIN: $Sn=59$ or $Sn=118$.

Stannum. F. *Etain.* G. *Zinn.*

Tin is mentioned by Moses under the name *Bedel.* It was used by the Egyptians. The Greeks and Romans obtained it through the Phœnicians from England. In the East it abounds in the districts between Mergui and the island of Banca. It occurs both as an oxyde and as a sulphide, but chiefly the former, which is easily reduced to a metallic state by charcoal. It is brought into commerce in the form of grain tin and block tin. Malacca tin, Banca tin, and Mergui tin are the Eastern varieties.

Tin is a bright white metal, tarnishing but slightly; of a peculiar odour when rubbed; so soft and malleable as to allow of being beaten into *sheet-tin* and *tin-foil;* sp. gr. 7·29; that of commercial specimens is often higher, from the impurities which they contain; fusible at 442°, and then becomes covered with a grey crust of binoxyde; burns at a red, and is volatilised at a white, heat.

When boiled with hydrochloric acid, tin is dissolved with extrication of hydrogen and formation of protochloride. *Pulvis stanni,* made by sharply triturating the fused metal, has been employed as an anthelmintic. The *tin-foil* so largely used by druggists to wrap up medicines and form capsules for bottles, is an alloy of tin, and contains from 25 to 75 per cent. of lead. The lead is dangerous on account of the ease with which it is corroded; treated with nitric acid, the lead is dissolved and an insoluble binoxyde of tin remains.

Nitric acid of sp. gr. 1·3 rapidly converts tin into hydrated binoxyde, with the liberation of ammonia (see p. 70). Tin combines directly with sulphur, phosphorus, chlorine, and bromine when heated with them.

Banca tin is almost chemically pure. Cornish tin usually contains small quantities of iron, lead, copper, arsenicum, and traces of gold.

It may be obtained perfectly pure by making a concentrated solution of crude tin in hydrochloric acid, cautiously pouring on this dense solution, so as to avoid admixture, a layer of water, and then placing a bar of tin in the liquid. Pure tin in foliated crystals is gradually deposited at the junction between the metallic solution and the water (Miller).

1. Granulated Tin, *P.B.*

Is prepared by fusing the metal, and pouring it into cold water.

CHARACTERS OF THE SALTS OF TIN.—1. Protosalts rapidly absorb oxygen, and their solutions become milky when largely diluted. The *caustic alkalies* give a white precipitate of hydrated protoxyde ($2SnO,H_2O$), soluble, excepting with ammonia, in excess; a characteristic chocolate-brown precipitate (SnS) with sulphuretted hydrogen and ammonic hydrosulphide, soluble in the alkaline bisulphides; with a dilute solution of auric chloride, a brown precipitate of reduced gold, or purple of Cassius. 2. Persalts give, with caustic alkalies, a white precipitate soluble in excess. Sulphuretted hydrogen and ammonic hydrosulphide give a dingy yellow precipitate of hydrated bisulphide (SnS_2).

The carbonates of the alkalies give, with both classes of salts, a precipitate of the respective oxyde, with escape of carbonic anhydride.

Solution of Chloride of Tin, *P.B.* SnCl or $SnCl_2$.

Dilute 3 fluid ounces of *hydrochloric acid* in a flask with 1 ounce of *water*, and having added 1 ounce of *granulated tin*, apply a moderate heat until gas ceases to be evolved:—$Sn + 2HCl = SnCl_2 + H_2$. Add water to measure 5 fluid ounces, and transfer the solution, together with the undissolved tin, to a bottle with an accurate stopper. The presence of metallic tin is required to prevent the formation of perchloride ($SnCl_4$).

Pharmaceutical Uses.—To indicate the presence of mercury in ammoniated mercury, and of red oxyde in mercury with chalk.

ANTIMONY: Sb=122 or $Sb=122$.

Antimonium. Stibium. F. *Antimoine.* G. *Antimon.*

Metallic antimony was probably known to the alchemists; but Basil Valentine (*Currus Triumphalis Antimonii*) made known the method of obtaining it. The sesquisulphide, grey or black antimony, has been known from the earliest times. It is the most abundant ore. Native antimony occurs in France and Germany; the other ores are white antimony (sesquioxyde, Sb_2S_3) and red antimony (oxysulphide $Sb_2O_3,2Sb_2S_3$). Antimony is obtained by heating the sesquisulphide with half its weight of iron filings or small iron nails, when the sulphur unites with the iron, and the antimony is set free. The melted antimony collects in the bottom of the crucible, and may be run into moulds. Commercial antimony frequently contains iron, copper, lead, and arsenicum. In order to remove the latter, four parts of the finely powdered metal are intimately mixed with five of nitrate and two of carbonate of soda, and heated to redness in a Hessian crucible. After deflagration is complete, the crucible is covered and the mass is kept in a semifused condition for half an hour, it is then pulverised, lixiviated with boiling water from the arseniate of soda, and the insoluble sodic antimoniate is reduced to metallic antimony by melting it with half its weight of crude tartar (Wöhler).

Properties.—A bluish-white very brittle metal, usually lamellar in structure; sp. gr. about 6·7. It is unchanged by exposure to air. It fuses at about 1150°, and in cooling may be obtained in rhombohedra. At a bright red heat it is slowly volatilised. Heated to a white heat, and suddenly exposed to the air, it burns with a white light; the vapour which escapes condenses in white needle-like crystals of sesquioxyde. Antimony is dissolved by HCl with the aid of heat, hydrogen being disengaged. It is oxydised by nitric acid and by boiling sulphuric acid.

Oxydes of Antimony.—These are—1. Antimonious oxyde or sesquioxyde, the old teroxyde (Sb_2O_3); 2. Antimonic anhydride or antimonic acid (Sb_2O_5); and 3. Antimonious antimoniate (Sb_2O_3, Sb_2O_5).

Characters of the Salts of Antimony.—A white precipitate with *caustic potash and soda* (unless tartaric acid is present), soluble in excess. *Ammonia and the carbonates of the alkalies* give a white precipitate, nearly insoluble in excess. In acid solutions, an orange-coloured precipitate ($Sb_2S_3,3H_2O$) of hydrated sesquisulphide with *sulphuretted hydrogen* soluble in ammonic hydrosulphide.

Antimony may be readily detected in solution by acidulating with a few drops of hydrochloric acid, and then boiling with a slip of copperfoil. The antimony is deposited as a bluish film, and when the slip is dried and heated in an open tube, the antimony is volatilised, oxydised, and deposited in needles of sesquioxyde.

Antimony, like arsenic, forms, with hydrogen, antimoniuretted hydrogen (H_3Sb). The distinction between the two is given at p. 290.

ANTIMONII OXYDUM, *P.B.* *Oxyde of Antimony.*

$SbO_3 = 146$ or $Sb_2O_3 = 292$.

Antimonious Oxyde. Sesquioxyde of Antimony or *Teroxyde. Flowers of Antimony.* F. *Oxyde d'Antimoine.* G. *Antimonoxyd.*

Teroxyde of antimony occurs native in Bohemia and Hungary, and is called white antimony ore. It may be produced by burning antimony in the air, or by precipitation, thus:—

Preparation.—Pour 16 fluid ounces of *solution of chloride of antimony* into 2 gallons of *water*, mix thoroughly, and set aside until the precipitate which forms shall have subsided. Remove the supernatant liquid by a siphon, add 1 gallon of *water*, agitate well, let the precipitate subside, again withdraw the fluid, and repeat the processes of affusion of water, agitation, and subsidence. To the precipitate add 6 ounces of *carbonate of soda*, previously dissolved in 2 pints of *water;* leave them in contact for half an hour, stirring frequently; collect the deposit on a calico filter, and wash with boiling water until the washings cease to give a precipitate with a solution of nitrate of silver, acidulated by nitric acid. Lastly, dry the product at a heat not exceeding 212°.

When a solution of terchloride of antimony is poured into a large body of water, a white precipitate of insoluble oxychloride ($SbCl_3, Sb_2O_3$), *powder of Algaroth*, as it was formerly called, falls, and a quantity of hydrochloric acid is set free, water being decomposed, the hydrogen uniting with the chlorine and the oxygen with the antimony ($3SbCl_3 + 3H_2O = SbCl_3, Sb_2O_3 + 6HCl$). The acid is first washed out of the precipitated oxychloride, and it is then decomposed by carbonate of soda, $2(SbCl_3, Sb_2O_3) + 3Na_2CO_3 = 3(Sb_2O_3) + 6NaCl + 3CO_2$. The whole of the terchloride is thus converted into sesquioxyde, which is washed free from chloride of sodium.

Characters and Tests.—A greyish-white powder, fusible at a low red heat; at a higher temperature and in a closed vessel it volatilises unchanged, and is deposited in brilliant prisms or occasionally in octohedra, both forms being isomorphous with arsenious acid. In the open air it burns like tinder, and is converted into antimonious antimoniate (Sb_2O_4). It is insoluble in water, but readily dissolved by hydrochloric acid, and solutions of caustic potash and soda. The solution in hydrochloric acid, dropped into distilled water, gives a white deposit (of oxychloride), at once changed to orange by sulphuretted hydrogen (Sb_2S_3). It dissolves entirely when boiled with an excess of the acid tartrate of potash (forming tartarated antimony).

Action.—When absorbed, this is identical with that of tartrated antimony, but its absorption appears to be very uncertain, and this may probably be explained by the presence or absence of gastric acid in the stomach at the time of, and subsequently to, its ingestion. It is emetic, diaphoretic, and expectorant. It is a good substitute for the following preparation.

Dose.—1 to 4 grains, in powder or pill.

Pharmaceutical Uses.—It is employed in the preparation of the Antimonium tartaratum and the Pulvis antimonialis.

Pulvis Antimonialis, *P.B. Antimonial Powder. James's Powder.*

Few empirical medicines have attained more permanent celebrity than the *fever powder* of Dr James, commonly called *James's Powder*, sometimes distinguished in prescriptions as the *Pulvis Jacobi verus.* As it was found impossible to make the powder by following the patentee's directions, and chemical analyses having ascertained that it consisted of phosphate of lime and oxydised antimony, the Pharmacopœia has adopted the following formula:—

Preparation.—Mix thoroughly 1 ounce of *oxyde of antimony* and 2 ounces of *phosphate of lime.*

Characters and Tests.—A white, tastelesss inodorous powder; insoluble in water, soluble in hydrochloric acid; the acid solution gives an orange precipitate (Sb_2O_3) with sulphuretted hydrogen, and after saturation with the gas and separation of the sulphide of antimony, the solution, after expulsion of the excess of sulphuretted hydrogen by boiling gives, a white precipitate ($3Ca2PO_4$) with ammonia.

Action and Uses.—If the conclusion be correct that the sesquioxyde of antimony is the active constituent of James's powder, the present preparation is worse than an encumbrance of the Pharmacopœia, because it seems to imply that the admixture with phosphate of lime renders the sesquioxyde more active than it would be if given alone, or give it an action which the latter does not possess, neither of which inferences have any foundation in fact.

It is diaphoretic, and in large doses emetic. It is more active than James's powder, of which 100 grains have been given without effect. Tartar emetic in small doses may be used as a substitute, it is far more efficacious.

Dose.—3 to 10 grains.

LIQUOR ANTIMONII CHLORIDI, *P.B. Solution of Chloride of Antimony.*

$SbCl_3=228{\cdot}5$ or $\mathbf{SbCl_3}=228{\cdot}5$.

Terchloride of antimony is the *butter of antimony* of the old writers. It is a crystallisable but very deliquescent salt, and a powerful emetic.

The Pharmacopœia employs a strong solution, thus prepared.

Preparation.—Place 1 pound of *black antimony* (sesquisulphide) in a porcelain dish, and pour upon it 4 pints of *hydrochloric acid*, constantly stirring; apply a gentle heat at first, then, as the evolution of gas (H_2S) begins to slacken, increase it to boiling, maintain it at this temperature for fifteen minutes, then filter, and boil down the clear liquor to 2 pints, and preserve in a stoppered bottle.

In the above process there is simply an interchange of metal or metalloid between the chlorine and the sulphur: $Sb_2S_3 + 6HCl = 2SbCl_3 + 3H_2S$. The chloride of antimony is dissolved in excess of acid.

Characters and Tests.—A heavy liquid; sp. gr. 1·47; of a yellowish-red colour. A little of it dropped into water gives a white precipitate (oxychloride), and the filtered solution lets fall a copious deposit on the addition of nitrate of silver ($AgCl$). If the white precipitate formed by water be treated with sulphuretted hydrogen it becomes orange-coloured (Sb_2S_3). One fluid drachm of it mixed with a solution of a quarter of an ounce of tartaric acid in 4 fluid ounces of water forms a clear solution, which, if treated with sulphuretted hydrogen, gives an orange precipitate, weighing, when washed and dried at 212°, at least 22 grains.

If the solution be subjected to distillation water and hydrochloric acid first pass over, and then the solid crystalline sesquichloride.

Impurities.—The solution contains traces of lead, iron, copper and arsenic, derived from the crude antimony, but these remain in solution when the oxychloride is precipitated by admixture with water, and thus these impurities are eliminated in the preparation of the oxyde and tartar emetic.

Action. Uses.—Butter of antimony is an energetic caustic. It spreads like caustic potash, and must be used with the same precautions. It has been recommended for poisoned bites and for staphyloma of the eye.

Pharmaceutical Uses.—The preparation of the oxyde of antimony.

ANTIMONIUM NIGRUM, *P.B.* *Black Antimony.*

$SbS_3 = 170$ or $Sb_2S_3 = 340$.

Sesquisulphide or *Tersulphide of Antimony.* *Antimonious Sulphide.*
F. *Sulfure d'Antimoine.* G. *Dreifach Schwefel Antimon.*

This mineral is extensively diffused, and is usually found in slate and granite rocks. It occurs in masses composed of acicular four-sided striated prisms. It has been employed from time immemorial in Asiatic countries for darkening the eyebrows and eyelids. It is the *Στίμμι* and Stibium of the ancients.

For pharmaceutical use it is purified from silicious matter by fusion, and afterwards reduced to fine powder.

Characters and Tests.—A heavy greyish-black powder, with minute crystalline particles which reflect the light; sp. gr. 4·6; insoluble in water, easily reduced to a soft impalpable powder. It fuses below a red heat, and forms a crystalline mass on cooling. It may be sublimed unchanged in close vessels, but if air be admitted it is converted into a mixture of antimonious sesquioxyde and sesquisulphide, which when fused forms a fine red "*glass of antimony.*" This glass dissolves silica, attacking the earthen crucibles in which it is fused.

Black antimony is almost entirely soluble in hydrochloric acid, evolving sulphuretted hydrogen (see Liquor antimonii chloridi), and in caustic potash or soda (see Antimonium sulphuratum).

Sulphide of antimony and chlorate of potash form an explosive mixture when heated.

Impurities.—It commonly contains lead, arsenic, and a little iron and copper pyrites. The lead is separated from the solution in hydrochloric acid by virtue of the insolubility of the plumbic chloride: the other impurities remain in the solution, but are separated from the antimony when it is precipitated as oxychloride, as in the preparation of the oxyde; or when the sulphide is dissolved in caustic alkalies, as in the preparation of sulphurated antimony.

The arsenic may be separated by digesting the black antimony in solution of carbonate of ammonia containing no free ammonia.

Action. Uses.—Almost inert, but uncertain, as it may be more or less oxydised by acid in the stomach.

1. **Antimonium Sulphuratum,** *P.B. Sulphurated Antimony. Oxysulphuret* and *Golden Sulphuret. Sulphur Antimonii Præcipitatum.* F. *Soufre doré d'Antimoine.* G. *Goldschwefel.*

This preparation, which is hydrated sesquisulphide of antimony, with a small and variable quantity of sesquioxyde, may be represented by the formula $5Sb_2S_3 + Sb_2O_3 + H_2O$. It was known to Basil Valentine.

Preparation.—Mix 10 ounces of *black antimony* with 4½ pints of *solution of soda;* boil for two hours, frequently stirring, adding *distilled water* that it may fill up the same measure. Strain the solution, and pour in gradually *dilute sulphuric acid* till in slight excess. Collect the precipitate on a calico filter, wash with *water* till the washings no longer precipitate with chloride of barium, and dry at a heat not exceeding 212°.

In this process the antimonious sulphide is dissolved in the caustic soda with the formation of sulphide of sodium and sesquioxyde of antimony, $6NaHO + Sb_2S_3 = 3Na_2S + Sb_2O_3 + 3H_2O$. The former dissolves some sesquisulphide of antimony, forming Na_3SbS_3, and the latter combines with soda to form Na_3SbO_3, both salts remaining in solution; and on the addition of sulphuric acid both are decomposed, sodic sulphate, antimonious sulphide, and water being formed,

$$Na_3SbS_3 + Na_3SbO_3 + 3H_2SO_4 = 3Na_2SO_4 + Sb_2S_3 + 3H_2O.$$

A little antimonious oxyde escapes decomposition and falls in admixture with the sulphide.

Kermes mineral, which achieved a great reputation at the beginning of the eighteenth century, is formed in the earlier part of the above process, and may be obtained by allowing the solution of sulphide in solution of soda to cool, when the compound in question ($2Sb_2S_3,Sb_2O_3$) is deposited as a reddish-brown powder.

Characters and Tests—An orange-red powder, readily dissolved by caustic soda, also by hydrochloric acid with the evolution of sulphuretted hydrogen, and the separation of a little sulphur. Boiled in water with acid tartrate of potash, the resulting solution is precipitated orange-red (hydrated sesquisulphide), with sulphuretted hydrogen (proving the presence of oxyde, which is dissolved by the excess of tartar. According to Mr Phillips, sulphurated antimony contains 12 per cent. of its weight of oxyde). 60 grains dissolved in hydrochloric acid and dropped into water give a white precipitate (of oxychloride) which, when washed and dried, weighs about 53 grains.

Under the influence of heat it behaves in the same way as the anhydrous sulphide—black antimony.

Action. Uses.—Diaphoretic and expectorant. In large doses (20 grains), emetic; in still larger, a gastro-intestinal irritant.

Dose.—1 to 5 grains.

Pharmaceutical Uses.—In the preparation of Pilula hydrargyri subchloridi composita, or *Plummer's pill.*

ANTIMONIUM TARTARATUM, *P.B.* *Tartarated Antimony.*

$KO,SbO_3,C_8H_4O_{10}+2HO$ or $KSbC_4H_4O_7,H_2O$.

Tartrate of Antimony and Potash. Antimonii Potassio-Tartras. Tartarised Antimony. Tartar Emetic. F. *Tartre Émètique.* G. *Brechweinstein.*

The discovery of this salt is attributed to Mynsicht (Thesaurus, &c., Hamburgh, 1631). As this salt is of definite composition, there is no excuse for the use of the obscure and unscientific name given in the Pharmacopœia.

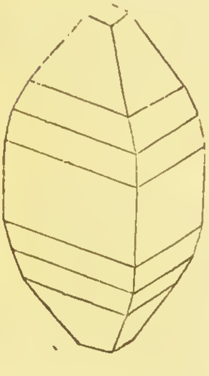

Fig. 46.

Preparation.—Mix 5 ounces of *oxyde of antimony* and 6 ounces of *acid tartrate of potash*, with sufficient *water* to form a paste, and set aside for twenty-four hours. Then boil it in 38 ounces of water for 15 minutes, frequently stirring. Filter, and set aside to crystallise. Evaporate the mother liquor to one-third, and get a second crop of crystals. Dry them on filtering paper at the temperature of the air.

The acid tartrate of potash forms a double salt with the oxyde of antimony, just as it does with soda and peroxyde of iron, in the tartarated soda and tartarated iron, and in the above process the sesquioxyde of antimony merely displaces an equivalent of basic water, thus: $2KHC_4H_4O_6+Sb_2O_3=2KSbC_4H_4O_7+H_2O$. The excess of oxyde employed does not dissolve, and is separated by filtration. The salt crystallises with an equivalent of water.

Characters and Tests.—In minute colourless transparent crystals, short square prisms exhibiting triangular facets at the ends, and rhombic octohedra; soluble in about 15 parts of cold, and twice their weight of boiling water; insoluble in alcohol, sparingly soluble in proof spirit. Exposed to the air they effloresce slightly, losing about 5 per cent. of water, and become milky-white and opaque, so that the crystalline structure of the powder is not very apparent. Dried at 212° the salt becomes anhydrous. At 392° it loses another equivalent of water, and has the composition ($KSb,C_4H_2O_6$); and it is remarkable, that when this body is dissolved in water it furnishes simply a solution of tartar emetic. Tartarised antimony when strongly heated, decrepitates, chars, and leaves a pyrophoric alloy of antimony and potassium. The aqueous solution reddens litmus, gives with hydrochloric acid a white precipitate (Sb_2O_3), soluble in excess, but which is not formed if tartaric acid be previously added. The oxyde is also precipitated by alkalies, and the alkaline earths and their carbonates. 20 grains dissolve without residue in a fluid ounce of distilled water at 60° (absence of lead and lime), and the solution gives with sulphuretted hydrogen an orange precipitate (hydrated Sb_2S_3), which when washed and dried at 212° weighs 9·91 grains (proving the proper proportion of antimony).

Incompatibilities.—Acids, alkalies, and their carbonates; lime water, chloride of calcium; the acetates of lead; astringent vegetable infusions and decoctions, as of cinchona, catechu, &c. The solution of tartar emetic in water is liable, if kept long, to undergo decomposition, with the formation of a fungus. This is prevented by the addition of spirit.

Action. Uses.—Tartar emetic is absorbed directly into the blood, and is eliminated by the intestines and kidneys. In large doses it produces violent gastro-intestinal inflammation, and in smaller and frequently repeated doses chronic enteritis and ulceration of the solitary and agminated glands of the intestines. It may be readily detected after ingestion in the parenchymatous organs and in the blood. Externally applied, is *rubefacient* and *irritant.* Its application, as in the form of ointment, is succeeded by an eruption of pustules. It is used in this manner as a counter-irritant in chronic affections of the chest and joints.

For internal use this is the best and most active of all the antimonial preparations. Its operation varies with the dose given. In a very small dose it is diaphoretic and expectorant. In a larger dose it excites nausea, causing at the same time great depression, cold sweating, relaxation of the muscular system, with slowness and weakness of the pulse. In a full dose it is emetic. Its operation is accompanied and succeeded by great nervous and vascular depression, often with purging. If the dose, at first small, be gradually increased, a considerable quantity may be given without causing vomiting. In this manner it is given as an antiphlogistic in pneumonia and other acute inflammations. Acting on the skin and lungs it is a most valuable remedy in acute bronchitis and in feverish catarrh, and in chronic bronchitis with viscid and retained secretion.

As a *nauseant* it is of use to prepare for the reduction of dislocations and herniæ, by relaxing the muscular system. As an emetic it may be given at the commencement of bilious fever, or to cut short at its outset an acute local inflammation. It aids the operation of purgatives. As an antiphlogistic it may be prescribed in fevers, to relax the skin and lower the pulse; also in acute rheumatism. In the early stage of croup, and when false membrane has formed, an occasional nauseating dose is invaluable. It should be avoided in apoplexy and peritonitis, as in these cases the occurrence of vomiting might be dangerous.

Dose.—As an alterative, $\frac{1}{16}$ to $\frac{1}{8}$ of a grain; as a diaphoretic and expectorant, $\frac{1}{8}$ to $\frac{1}{6}$ of a grain; as a nauseating sudorific or depressent, $\frac{1}{4}$ to $\frac{1}{2}$ grain every two or three hours; as an emetic, 1 to 2 grains diluted.

Antidotes.—Excite vomiting by mechanical irritation in the fauces, or with draughts of warm water; or use the stomach pump. The best antidotes are astringent vegetable decoctions or infusions, as of gall-nuts or of cinchona, as these form insoluble tannates with the teroxyde of antimony.

1. Vinum Antimoniale, *P.B.* *Antimonial Wine.*

1 fluid ounce contains 2 grains of the salt; being a solution of 40 grains of *tartarated antimony* in 1 pint of *sherry.*

Dose.—5 minims ($=\frac{1}{48}$ grain) to 1 fluid drachm ($=\frac{1}{4}$ grain) every three hours as a diaphoretic and depressent. As an emetic, 2 to 4 fluid drachms every fifteen minutes until emesis is induced; for children, 1 fluid drachm every five or ten minutes.

2. Unguentum Antimonii Tartarati, *P.B.* *Antimonial Ointment.*

Composed of $\frac{1}{4}$ ounce of *tartarated antimony* in fine powder, thoroughly mixed with 1 ounce of *simple ointment.*

Action. Uses.—Counter-irritant. 30 grains rubbed into the skin twice a day, produces a pustular eruption. A valuable application in acute synovitis; in phthisis instead of blisters; and in chronic peritonitis, and other local inflammations of the chest and abdomen.

MERCURY: Hg=100 or **Hg**=200. *Quicksilver.*

F. *Mercure.* *Vif-argent.* G. *Quecksilber.*

This metal was known to the ancients. Both the Romans and the Arabs seem to have employed it externally as a medicine; but the Hindoos were probably the first to prescribe it internally. It is found in China, at Almaden in Spain, and Idria in Carniola. Immense mines of quicksilver have been lately worked in California. It occurs occasionally in metallic globules; usually as the native sulphide or *cinnabar;* combined with silver, forming a *native amalgam;* or with chlorine, as in *horn mercury.* It is chiefly obtained from the sulphide by distillation with lime or iron, which combines with the sulphur, and the metal distils over and is condensed.

Properties.—Mercury is remarkable among metals for existing as a liquid at ordinary temperatures, and for its silver-like colour and lustre; sp. gr. 13·56; freezes at −38°, crystallises in octohedra, becomes malleable, and has a sp. gr. of 14 from the contraction. It boils at 662°, and is converted into colourless vapour of great density. (According to Faraday, it is converted into vapour at ordinary temperatures.) It is unalterable in the air, except at high temperatures. At 700° it slowly combines with oxygen, and forms the red oxyde. By increase of heat, the oxygen is again expelled. Mercury combines directly with chlorine, bromine, iodine, and sulphur at the temperature of the air. It dissolves gold, silver, lead, tin, bismuth, zinc, forming amalgams. Mercury is unaffected by hydrochloric acid, either cold or hot. Hot sulphuric and strong nitric acids oxydise and combine with it, the former with evolution of sulphurous anhydride, the latter with extrication of nitric oxyde.

Commercial mercury is almost chemically pure, but on account of the facility with which it combines with many metals, it may readily acquire impurities. If it be thus contaminated it loses lustre, and has a tendency to adhere to a sheet of dry, smooth paper when rolled over it. It may be purified from mechanical impurities by straining through wash-leather, or filtering through a pin-hole in a sheet of letter paper; and a prolonged digestion with cold diluted nitric acid will remove any chemical impurity.

Hydrargyrum, *P.B.* *Mercury.*

Should be brilliantly lustrous, easily divisible in spherical globules, and volatile without residue at a heat below that of visible redness.

Oxydes of Mercury.—Of these there are two—the black suboxyde, Hg_2O, and the red oxyde, HgO; both are salifiable, and both are employed in medicine (see below).

Characters of Salts of Mercury.—Completely volatilised by heat. If volatilised in a glass tube ¼ inch in diameter, through a layer (1 inch deep) of carbonate of soda, the upper part of which is heated to redness, a sublimate of minute spherules of mercury is formed. A strip of copper-foil receives a deposit of mercury when placed in any of the solutions. A drop of a solution of a salt of mercury placed upon a gold coin receives a coating of mercury on touching the solution and coin simultaneously with a key or a piece of zinc. On heating the coin the mercury is dissipated. Both *sulphuretted hydrogen* and *ammonic hydrosulphide* produce black precipitates of subsulphide (Hg_2S) with the subsalts, and of sulphide (HgS) with the persalts.

The salts of mercury are all reduced to the metallic state when heated with a solution of protochloride of tin, and this is effected in the cold with some of them, thus:

$$2HgCl + SnCl_2 = S_2Cl_4 + 2Hg.$$

1. *Salts of the suboxyde* give a black precipitate (Hg_2O) with solutions of *potash*, *soda*, or *lime;* a white precipitate of calomel ($HgCl$) with *hydrochloric acid* and the *chlorides.* *Potassic iodide* precipitates

a green subiodide (HgI). 2. *Salts of the protoxyde* give with solutions of *potash*, *soda*, and *lime*, a bright yellow precipitate of protoxyde (HgO); a white precipitate (HgH_2NCl) with *ammonia.* Potassic or sodic *carbonate* gives a yellow precipitate of oxyde, their bicarbonates a red precipitate of oxychloride ($2HgO,HgCl_2$). A brilliant scarlet precipitate (HgI_2) with *potassic iodide.* No precipitate with *hydrochloric acid* or the *chlorides.*

Action and Uses of Mercurial Compounds.—Mercury is inert when taken into the stomach, unless it be retained for a long time, or be injected in a state of minute subdivision, as in the Hydrargyrum cum creta, when the constitutional effects of a soluble preparation of the metal are declared. But the case is far different when the mercury is introduced into the blood through the lungs. The effects of the vapour of mercury are seen amongst those who are engaged in water gilding (in which process an amalgam of gold and mercury is separated by heat—the latter metal being volatilised), and in the roasting of cinnabar and distillation of mercury; and it has been more than once illustrated on board ship, by the accidental escape of a large quantity of metallic mercury. In the case of "Phipps" schooner, within three weeks all the animals died. 200 men were salivated, of whom two died. The animals and men were no doubt unequally affected, as they are by carbonic acid in the "Grotto del Cane," on account of the great density of the mercurial vapour, viz., 6·976. The effects commonly produced by the vapour of mercury are, only slight symptoms of salivation and that remarkable irritative debility of the motor centres which results in "paralysis agitans" or "the trembles." There is great debility on making an effort to walk, and the limbs are too tremulous to support the patient. The speech is similarly affected; there is usually anorexia and constipation, but no febrile disturbance. In extreme cases there is disturbance of the intellectual functions. Salts of mercury introduced by the skin or mouth only manifest the above effects after severe salivation and prolonged use. The evidences of their action are almost always confined to the alimentary canal; these are a brassy taste, slight redness and swelling of the gums and tenderness of the teeth, with fœtor of the breath like that which usually accompanies acute tonsillitis, and an increase of saliva. These are the sufficient indications of the absorption of mercury and its action upon the system, and they should never exceed this degree, which we may designate as "*moderate mercurialism.*" If the action exceed these moderate limits, there will be profuse ptyalism, suppurative inflammation, and ulceration of the gums with loosening of the teeth, severe neuralgic pains in the jaws, and swelling of the salivary glands, usually accompanied by febrile disturbance, and sometimes by diarrhœa. Mercurialism is very rapidly effected in some persons; indeed, it has happened that a single dose of 5 grains of calomel has produced severe ptyalism. In the pyrexial condition, on the other hand, it is produced slowly, and often with great difficulty. To produce moderate mercurialism we may employ blue pill or calomel. The perchloride is not suitable for this purpose, its irritant, corrosive action leading to its speedy evacuation by the intestines.

Blue pill and calomel are dissolved in the stomach or intestines, and pass thence into the blood. Such mercurials tend to impoverish this fluid, diminishing the amount of fibrine and corpuscles, and thus counteracting inflammation. For the same reason they promote absorption. In acute inflammation they arrest the process, in chronic cases they help to remove deposits. As an antiphlogistic, mercury is inferior to antimony, being slower in its action; but its effect is more lasting, and it is of especial use in inflammations of the serous membranes and parenchymatous organs. In gout it is serviceable as a cholagogue; in rheumatism it is useless.

Besides being thus useful in inflammations generally, mercury is of especial value in syphilitic disorders, which it holds under special control. In the primary disease, when the sore is not sloughing, or the constitution radically enfeebled, it is the best of all remedies. It is generally combined with opium, which prevents it from passing off by the bowels. In syphilitic iritis it is indispensable, but in periostitis and other late affections it is inferior to iodide of potassium. These actions of mercury in the blood are commonly classed together under the title of *Alterative*, which is peculiarly given to this remedy.

Mercury at length leaves the blood, and passes out by the glands, stimulating all the secretions. It is diaphoretic, diuretic, and sialagogue; also cholagogue and cathartic. For this latter action it is commonly given, alone or with other purgatives, in those very frequent cases where an action upon the liver as well as on the bowels is desired. As a cathartic in full habits of body, or in dyspeptic or gouty subjects, mercury is of great service. It may be given to children with safety. Calomel and other mercurials have been largely given in cholera; but their utility in this disorder is a matter of doubt. In scrofula, ague, and anæmic disorders, they may do good by acting on the liver.

The preparations of mercury are sometimes used externally. The oxydes, in the form of black and yellow wash, are applied to sores and eruptions of syphilitic origin. Mercurial ointment is extensively used as a stimulant and alterative application to the surface, and by its absorption to produce mercurialism.

Pharmaceutical Uses.—Metallic mercury is employed directly or indirectly in all the 24 preparations contained in the Pharmacopœia, and in 8 of them (those first following) it exists for the most part in the uncombined state.

1. **Hydrargyrum cum Creta**, *P.B. Mercury with Chalk. Grey Powder.*

Composed of 1 part of metallic mercury in a state of minute subdivision, mixed with 2 parts of chalk.

Preparation.—Rub 1 ounce by weight of *mercury* and 2 ounces of *prepared chalk* in a porcelain mortar until metallic globules cease to be visible to the naked eye, and the mixture acquires an uniform grey colour.

[Wholesale manufacturers generally mix the ingredients by rapid rotation in a cask turning on an axis.]

When water is added to the chalk, as recommended by Mr Phillips, or when the mercury is first rubbed with manna, as ordered in the old edition of the D. P., a minute portion of the metal probably becomes oxydised during the process of trituration. Dr Nevins found in the latter case that a little (about $\frac{1}{2}$ grain in 100 grains of the Hydrargyrum cum creta) is in the state of suboxyde.

Characters and Tests.—A light grey, impalpable powder, which exhibits no metallic globules when a little rubbed with the tip of a finger on a sheet of smooth paper; insoluble in water; the greater part soluble with effervescence (CO_2) in hydrochloric acid, leaving the mercury in a finely divided state. The solution formed with hydrochloric acid is not precipitated by the addition of chloride of tin (indicating the absence of red oxyde, which if present would form soluble chloride with the acid:—see characters of the salts of mercury, p. 265). Heated, mercury sublimes in globules, and leaves a residue of chalk; or if the heat be strong, of lime, a solution of which in hydrochloric acid is not precipitated by sulphuretted hydrogen, showing the absence of lead, zinc, tin, or other metallic impurities.

Incompatibilities.—Acids and acid salts. Sulphates, chlorides, and acetates.

Action. Uses.—Mild alterative, cathartic, and antacid. 2 grains night and morning, combined with 3 to 5 grains of compound ipecacuanha powder, usually produce slight mercurialism in the course a week or nine days.

Dose.—5 to 30 grains for adults; 2 to 5 grains for children, in confection or some viscid fluid.

2. **Pilula Hydrargyri**, *P.B.* *Mercurial Pill.* *Blue Pill.*

This forms a mass of a bluish colour and soft texture, 3 grains of which contain 1 grain of mercury minutely subdivided.

Preparation.—Rub together 2 ounces of *mercury* and 3 ounces of *confection of roses* till metallic globules are no longer visible. Then add 1 ounce of *liquorice root* in fine powder, and mix the whole well together.

Steam power is now usually employed, which is an advantage, as the efficacy of the pill depends upon the extent to which the mercury is subdivided. According to Dr Nevins, a trace of suboxyde is formed in processes similar to the above, and it is very probably that this combines, in the present preparation, with the vegetable acid of the confection to form a salt of mercury. Sulphuric acid is sometimes added to the confection to brighten the colour; and in this case a very active and irritant salt of mercury, the subsulphate (*Turpeth's mineral*), would be formed.

Tests.—When thoroughly washed with cold water, a heavy residue of finely divided mercury remains, and if this be boiled with water accidulated with hydrochloric acid, the acid fluid gives no precipitate (of mercury) with solution of protochloride of tin, nor with sulphuretted hydrogen (absence of metallic impurities). This pill ought to display no globules when rubbed on paper.

Action. Uses.—Alterative, cathartic. Employed to produce mercurialism in syphilis and inflammatory disorders.

Dose.—3 to 5 or even 15 grains, as a purgative. 5 grains morning and evening to induce salivation, sometimes conjoined with a little opium, to prevent action of the bowels. 3 grains of the pill contain 1 grain of mercury.

3. **Unguentum Hydrargyri**, *P.B.* *Mercurial* or *Blue Ointment.* F. *Onguent Mercuriel.* G. *Graue Quecksilbersalbe.*

Composed of equal parts nearly of finely divided mercury and solid fat.

Mercury in this form seems to have been employed medicinally by the Romans. Pliny says that mercury is poisonous, "unless, indeed, it is to be administered in the form of an unction on the belly, when it will stay bloody fluxes." (Holland's Transl. lib. 33, c. 8.) It was subsequently employed by the Arabs, and thence reintroduced into European practice.

Preparation.—Take 1 pound each of *mercury* and *prepared lard* and 1 ounce of *prepared suet.* Rub together until metallic globules are no longer visible.

As in the foregoing compounds, trituration produces a minute subdivison of the mercury, and this should be carried so far that on rubbing a minute portion with the tip of the finger on a piece of smooth writing paper, globules cannot be discovered by the naked eye. When this is the case, they are apparent under a low magnifying power. When newly prepared with fresh lard, no part of the mercury leaves the metallic condition; but after a time, or if the ointment have been prepared with more or less rancid lard, it appears that a small quantity of suboxyde, or perhaps a subsalt, is formed. The presence of the latter has been denied, and even when rancid lard is used, it may not be formed for some months, unless the subdivision of the mercury have been most completely effected. The complete subdivision, or "extinction" of the mercury, as it is called, is best effected by the aid of steam power, and by allowing the mixture to remain exposed to the air, triturating occasionally; so that the operation is not completed for some weeks. It has also been recommended to triturate the mixture with some old mercurial ointment, or, as Soubeiran recommends, with lard that has been exposed in thin layers in cellars from fifteen days to some months. It has lately been found that a small quantity of sulphate or nitrate of potash will assist in the extinction of the mercury.

M. Guibourt found that the 500th part of the ointment consisted of suboxyde of mercury combined with a fatty acid. Dr Christison states that he has never failed to detect a sensible proportion of this oxyde. On melting the ointment in a long tube, there is obtained a short column of mercury at the bottom, and a long superstratum of yellowish, almost perfectly transparent oil. This, even when filtered, becomes intensely black with sulphuretted hydrogen; and if agitated with successive portions of dilute acetic acid at 150°, an acid liquor is obtained, which gives a copious black precipitate of subsulphide of mercury with the same reagent. Hence, mercury must be present in the form of a suboxyde, combined with a fatty acid. Dr Christison says it exists in the proportion of about $\frac{1}{50}$th of the mercury used, or 1 per cent. of the ointment, and concludes with Dr Bærensprung (Pharm. Journ. x. 554) that it is the only active part of the ointment.

Tests.—The ointment is often carelessly made, and an insufficient quantity of mercury is sometimes used, when Prussian blue is added to give the required depth of colour. The sp. gr. of the properly-prepared ointment is 1·78. When rubbed on a smooth sheet of paper with the pulp of the finger, no globules should be visible with a magnifier of four powers; innumerable ones may be seen with the higher powers. The fatty matter may be separated by the joint action of boiling water and æther, and the residual mercury weighed.

Action, Uses, and Doses.—When rubbed into the skin, or taken internally, it produces mercurialism. In febrile affections, where this effect is not very readily induced, 60 grains of the ointment should be rubbed into the axillæ, or inside the thighs, while calomel or blue pill are simultaneously used internally. The hand of the operator should be protected with a leathern glove. On the Continent 2 to 5 grains made into pills with liquorice powder are given internally to produce speedy mercurialism. It is an appropriate application to syphilitic and indolent ulcers.

4. **Unguentum Hydrargyri compositum**, *P.B.* *Compound Mercurial Ointment.*

This contains rather less than ½ its weight of Unguentum hydrargyri, and $\frac{1}{9}$ of its weight of camphor.

Preparation.—Melt together 3 ounces each of *yellow wax* and *olive oil*, and when the mixture is nearly solid, add 1½ ounce of powdered *camphor* and 6 ounces of *ointment of mercury*, and mix thoroughly.

Action and Uses.—Those of Unguentum hydrargyri, but stimulant. The camphor is supposed to facilitate the absorption of the mercury, by exciting the cutaneous circulation.

5. **Linimentum Hydrargyri**, *P.B.* *Liniment of Mercury.*

This contains ⅓ of its weight of its Unguentum hydrargyri, and less camphor than the preceding: the mercury is suspended in ammoniacal soap.

Preparation.—Liquefy 1 ounce of *ointment of mercury* in 1 fluid ounce of *liniment of camphor* with a gentle heat; then add 1 fluid ounce of *solution of ammonia* gradually, and mix with agitation.

Action and Uses.—As a liquid form of mercurial ointment, it is convenient for combining with other liniments. Like the last two preparations, it is employed to promote absorption, and to excite salivation more readily by its stimulant action on the lymphatics.

6. **Emplastrum Hydrargyri**, *P.B.* *Mercurial Plaster.*

Contains $\frac{1}{3}$ of its weight of mercury, $\frac{1}{12}$ of which is in the condition of subsulphide, the remainder being in a minute state of subdivision, as in Unguentum hydrargyri.

Preparation.—Heat 1 fluid drachm of *olive oil* with 8 grains of *sulphur*, gradually added, until they unite. With this triturate 3 ounces of *mercury* until globules are no longer visible; then add 6 ounces of *lead plaster*, previously liquefied, and mix thoroughly.

Sulphurated oil (see p. 52) is formed in the first part of the process, and this greatly facilitates the subdivision of the mercury. A $\frac{1}{4}$ of an atom (in grains) of sulphur is used, and the mercury being in excess combines with it to form 108 grains of subsulphide.

Action. Uses.—Applied as a plaster, it stimulates the lymphatics of the part, whether this be a chronically enlarged joint, a node, glandular enlargement, or chronically diseased liver or spleen.

7. **Emplastrum Ammoniaci cum Hydrargyro**, *P.B.* *Ammoniacum and Mercury Plaster.*

Contains $\frac{1}{5}$ of its weight of mercury, $\frac{1}{12}$ of which is in the condition of subsulphide, the remainder in a state of minute subdivision (see the preceding).

Preparation.—Reduce 3 ounces of *mercury* to a state of minute subdivision by trituration, as in the preceding article, with the same quantity of *sulphurated oil*, and add gradually 12 ounces of melted *ammoniacum*, and mix carefully.

Action. Uses.—Similar in its effects to the last. Applied to enlarged glands and joints, or to indolent tumours.

8. **Suppositoria Hydrargyri**, *P.B.* *Mercurial Suppositories.*

Preparation.—Melt 20 grains each of *benzoated lard* and *white wax*, and 80 grains of *oil of theobroma* with a gentle heat, then add 60 grains of *ointment of mercury*, and, having mixed all the ingredients thoroughly, without applying more heat, immediately pour the mixture, before it has congealed, into suitable moulds of the capacity of 15 grains; or the fluid mixture may be allowed to cool, and then be divided into 12 equal parts, each of which shall be made into a conical or other convenient form for a suppository.

Use.—Employed locally by the rectum or uterus to promote absorption of inflammatory products and tumours within or around the pelvic organs.

HYDRARGYRI SUBOXYDUM. *Suboxyde of Mercury.*

$Hg_2O = 208$ or $Hg_2O = 416$.

Hydrargyri Oxydum cinereum. F. *Protoxide de Mercure.* G. *Quecksilberoxydul.*

Contains in 100 parts, Hg 96·15 and O 3·85.

A dark grey powder, devoid of taste and smell; heavy—sp. gr. 10·69; insoluble in water; easily decomposed by light, and by a heat even of 212°, being resolved into metallic mercury and red oxyde, and assuming a yellowish or olive hue. Dissipated at 600°. Readily dissolved by acetic acid or by dilute nitric acid, from which it is again precipitated black by caustic potash or soda. Hydrochloric acid, or the soluble chlorides, give a white precipitate (*calomel*) in solutions of its salts. It may be prepared by washing finely levigated calomel with solution of potash, soda, or lime, when a soluble chloride is formed, and the suboxyde is developed. It should be dried at a moderate heat, and kept from the light. A small portion of this oxyde has been detected in the foregoing preparations of metallic mercury.

Tests.—Shaken with excess of dilute hydrochloric acid, the solution, when separated from the calomel, should give no precipitate with solution of potash (proving the absence of red oxyde).

Action. Uses.—A mild mercurial; but uncertain on account of the formation of the very active red oxyde, and therefore seldom used internally.

Dose.—1 to 5 grains. Employed sometimes for fumigation. Externally as an ointment, 1 part to 3 or 5 of lard; or a lotion, as in the following preparation:—

1. **Lotio Hydrargyri nigra,** *P.B.* *Black Mercurial Lotion. Black Wash.*

A mixture of 30 grains of *calomel* and 10 ounces of *lime water.* Applied as a wash to syphilitic ulcers.

HYDRARGYRI OXYDUM. *Oxyde of Mercury.*

$HgO = 108$ or $HgO = 216$.

Mercuric Oxyde. *Peroxyde* or *Binoxyde of Mercury.* *Red Precipitate.* F. *Deutoxide de Mercure.* G. *Rothes Quecksilberoxyd.*

Contains in 100 parts, Hg 92·7 and O 7·3.

Two forms of this oxyde are prescribed in the Pharmacopœia; the only difference between them is that of physical condition—the one being red, in the form of a crystalline powder; the other yellow, in the state of an impalpable powder formed by precipitation.

1. **Hydrargyri Oxydum rubrum,** *P.B.* *Nitric or Red oxyde of Mercury.*

Preparation.—Dissolve 4 ounces of *mercury* in 4½ fluid ounces of *nitric acid,* diluted with 2 fluid ounces of *water.* Evaporate the solution to dryness, and with the dry salt thus obtained triturate 4 ounces more of *mercury* until the two are uniformly blended together. Heat the mixture in a porcelain dish with repeated stirring until acid vapours cease to be evolved, and when cold enclose the product in a bottle.

The mercury dissolves in the excess of dilute acid, forming subnitrate, water and nitric oxyde being liberated, the latter escaping in ruddy fumes, $3Hg + 4HNO_3 = 3HgNO_3 + 2H_2O + NO$. When the subnitrate is mixed with another equivalent of mercury and heated, it is decomposed, red oxyde of mercury and nitric oxyde being formed, $HgNO_3 + Hg = 2HgO + NO$. The nitric oxyde and some excess of nitric acid contained in the subnitrate are driven off by heat.

This oxyde may also be prepared by keeping metallic mercury for some time at a heat of 600° in a narrow-mouthed vessel, when it undergoes oxydation, and becomes converted into red scales of oxyde (*calcined mercury*).

Characters and Tests.—An orange-red crystalline powder; sp. gr. 10·68; readily soluble in hydrochloric, nitric, hydrocyanic, and acetic acids, but unaffected by a cold solution of oxalic acid; very slightly soluble in water (about 1 part in 5000); the solution has an acrid taste, and turns syrup of violets green. The solution in hydrochloric acid gives a yellow precipitate (HgO) with excess of caustic potash, and a white one (H_2HgNCl) with solution of ammonia. Entirely volatilised by a heat under redness, being at the same time decomposed into mercury and oxygen. If this be done in a test-tube no orange vapours (NO_2) are perceived (absence of undecomposed subnitrate).

2. **Hydrargyri Oxydum flavum**, *P.B.* *Yellow Oxyde of Mercury.*

This form of the oxyde is in a finer state of subdivision than the foregoing, and is therefore more active, chemically and medicinally. It is otherwise identical with the "nitric or red oxyde."

Preparation.—Dissolve 4 ounces of *perchloride of mercury* in 4 pints of *water* with the aid of heat, and add it to 2 pints of *solution of soda.* Stir, allow the yellow precipitate to subside, decant the supernatant fluid, and thoroughly wash the precipitated oxyde with *water* on a calico filter, and finally dry it by the heat of a water bath.

In this process the chlorine is transferred from the mercury to the sodium; the former is oxydised, and water is liberated:

$$HgCl_2 + 2NaHO = HgO + 2NaCl + H_2O .$$

It is necessary that the caustic soda be free from carbonate and always in excess; and in order to secure the latter condition, the mercurial solution must be added to that of the soda, otherwise an oxychloride of mercury would be formed.

Characters and Tests.—A yellow powder. A cold solution of oxalic acid converts it into oxalate of mercury; readily soluble in hydrochloric acid, forming a solution identical in its reactions with that of the red or nitric oxyde, and it is similarly affected by heat.

Water boiled with the oxyde gives no precipitate with ammonia or solution of nitrate of silver (showing absence of corrosive sublimate). Boiled with a solution of corrosive sublimate, it is rapidly converted into dark-brown insoluble flakes of oxychloride ($3HgO,HgCl_2$). By long exposure to light, the precipitated oxyde acquires a greyish colour, probably due to reduction to the metallic state.

Action and Uses.—Of these two forms of oxyde the precipitated is the more active. Both resemble corrosive sublimate in their irritant poisonous action; and they are not only unsuitable for internal use, but unnecessary, as no advantage is gained by using this preparation. Externally applied, and as an ointment, the oxyde is a valuable stimulant to unhealthy ulcers. Sprinkled undiluted on a granulating surface, it is violently stimulant, and even escharotic, and may be applied as such to venereal warts and chancres, and to spongy growths. It is rapidly absorbed, and if applied to an extensive ulcerated surface, produces salivation. It is used in the form of lotion and ointment in the following:—

3. **Lotio Hydrargyri flava,** *P.B. Yellow Mercurial Lotion. Yellow Wash.*

Prepared by shaking 18 grains of finely powdered *perchloride of mercury* with 10 fluid ounces of *solution of lime:*

$$CaOH_2O + HgCl_2 = CaCl_2 + H_2O + HgO.$$

Action and Uses.—See above.

4. **Unguentum Hydrargyri Oxydi Rubri,** *P.B. Ointment of Red Oxyde of Mercury,* or *Red Precipitate Ointment.*

Preparation.—Melt ¼ ounce of *yellow wax* at a gentle heat, mix ¾ ounce of *oil of almonds* with it, and when the mixture is nearly cold add 62 grains of the precipitated *oxyde of mercury.*

This ointment, when freshly made, is of a bright scarlet colour; but the oxyde by degrees becomes reduced, as is evident from the change of colour first to a greyish-red and then to a bluish-grey.

Action. Uses.—Stimulant, applied to indolent sores, and to the eyelids in chronic ophthalmia and tarsitis. Applied to large ulcerated surfaces, it soon produces mercurialism.

HYDRARGYRI IODIDUM VIRIDE, *P.B. Green Iodide of Mercury.*

$Hg_2I = 327$ or $HgI = 327$.

Mercurous Iodide or *subiodide.* F. *Proto-Iodure de Mercure.* G. *Quecksilberiodür.*

Contains in 100 parts, Hg 55·5 and I 44·5.

The subiodide of mercury was first introduced into medicine by M. Coindet.

Preparation.—Rub together 1 ounce of *mercury* and 278 grains of *iodine* in a porcelain mortar, occasionally moistening the mixture with a few drops of *rectified spirit* till the globules disappear, and the whole assumes a green colour. Dry the powder in a dark room by exposure to the air, and preserve it in an opaque bottle.

The mercury and iodine are mixed in the proportion of single atoms, and combine with such energy that considerable heat is evolved as they are rubbed together. The alcohol facilitates the combination by dissolving the iodine, and at the same time moderates the heat by its rapid evaporation. The subiodide may also be formed by mixing together solutions of iodide of potassium and subnitrate of mercury having a slight excess of nitric acid, and washing the precipitate.

Characters and Tests.—A dull green powder, insoluble in water, alcohol, and æther, and therefore, when shaken with the latter in a tube, nothing is dissolved (this proves the absence of red iodide, which is soluble in æther). It darkens on exposure to light (being slowly decomposed into metallic mercury and the red iodide); this change is immediately effected by heating it in a test tube, when it yields a yellow sublimate (red iodide), which on friction becomes red, while globules of metallic mercury are left in the bottom of the tube.

Impurities.—The only impurity is the red iodide, which may be present from allowing the temperature to rise too high in the preparation, and from exposure to the light. Mr C. H. Wood states that the green iodide, prepared according to the prescription of the Pharmacopœia, invariably contains some red iodide, but that it disappears if the trituration be continued until the iodide is *yellow.*

Action. Uses.—Identical with those of the red iodide, but milder. Considering, therefore, that this preparation is both unstable and of uncertain composition, it must be condemned as worse than a mere encumbrance of the Pharmacopœia.

Dose.—$\frac{1}{2}$ to 3 grains. With eight parts of lard it forms an ointment which is applied to scrofulous sores.

HYDRARGYRI IODIDUM RUBRUM, *P.B. Red Iodide of Mercury.*

$HgI = 227$ or $HgI_2 = 454$.

Mercuric Iodide or *Biniodide.* F. *Deutoiodure de Mercure.* G. *Doppelt Iodquecksilber.*

Contains in 100 parts, Hg 44·05 and I 55·95.

Iodide of mercury is a powder of a beautiful scarlet colour.

It may be obtained by the same process as the green iodide, using half the quantity of mercury. The Pharmacopœia very properly directs it to be formed by precipitation, as it ought to have done in the case of the green iodide.

Preparation.—Dissolve 4 ounces of *perchloride of mercury* in 3 pints, and 5 ounces of *iodide of potassium* in 1 pint of boiling *water*, and mix the two solutions. When the temperature of the mixture has fallen to that of the atmosphere, decant the supernatant liquor from the precipitate, and having collected the latter on a filter, wash it twice with cold distilled water, and dry it at a temperature not exceeding 212°.

The iodine and chlorine merely change places: $HgCl_2 + 2KI = HgI_2 + 2KCl$. The chloride of potassium is not thoroughly washed out of the precipitated iodide, as the presence of a trace is not objectionable, and a slight waste of the iodide is prevented.

Characters and Tests.—A minutely crystalline powder of a brilliant scarlet colour, becoming yellow when gently heated over a lamp on a sheet of paper; almost insoluble in water, soluble in solution of perchloride of mercury, or of iodide of potassium; sparingly soluble in cold but freely in hot alcohol, freely soluble in æther. When digested with solution of soda it assumes a reddish-brown colour (oxyde of mercury is separated and iodide of sodium formed in solution, $HgI_2 + 2NaHO = HgO + 2NaI + H_2O$), and the fluid cleared by filtration and mixed with solution of starch gives a blue precipitate (iodide of starch) on being acidulated with nitric acid (which liberates the iodine). Entirely volatilised by a heat under redness (392°), and is deposited in yellow rhombic plates, which, on being gently rubbed, break up into scarlet octohedra having a square base,—an instance at once of dimorphism and of the dependence of colour on molecular arrangement.

It is readily soluble without change, in solutions of the chlorides of the alkali metals; and with corrosive sublimate forms a soluble crystallisable double salt ($HgI_2,2HgCl_2$).

Impurities.—Sulphide of mercury (vermilion) has been employed as an adulterative. It may be readily detected by solution of iodide of potassium, which dissolves out the iodide and leaves the sulphide.

Action. Uses.—An irritant poison. Antisyphilitic, and alterative in scrofulous habits. *Externally*, rubefacient and vesicant.

Dose.—$\frac{1}{16}$th to $\frac{1}{8}$th of a grain dissolved with chloride of sodium, or in iodide of potassium which is a very suitable vehicle. A fluid drachm of Liquor hydrargyri perchloridi, mixed with a solution of from 1 to 5 grains of iodide of potassium in an ounce of water, is in every respect an advantageous method of prescribing the iodide.

1. **Unguentum Hydrargyri Iodidi Rubri**, *P.B.* *Ointment of Red Iodide of Mercury.*

Prepared by mixing 16 grains of the *red iodide*, in fine powder, with 1 ounce of *simple ointment.*

Use.—A stimulant application to ulcers, to promote healthy suppuration.

HYDRARGYRI SUBCHLORIDUM, *P.B.* *Subchloride of Mercury.*

$Hg_2Cl = 235{\cdot}5$ or $HgCl = 235{\cdot}5$.

Mercurous Chloride. Calomel (*Calomelas*). *Chloride* and *Mild Muriate of Mercury.* F. *Protochlorure de Mercure. Mercure doux.* G. *Einfach Chlorquecksilber.*

Contains in 100 parts, **Hg** 84·92 and **Cl** 15·08.

Calomel occurs native in Carniola and in Spain, and is called horn mercury and native calomel. It appears to have been prepared artificially by the Hindoos at very early periods (Fleming and Ainslie), and prescribed by them internally. It has been known in Europe since 1608.

Preparation.—Moisten 10 ounces of *sulphate of mercury* with *boiling water*, and rub it with 7 ounces of *mercury* until globules are no longer visible; add 5 ounces of dried *chloride of sodium*, and thoroughly mix the whole by continued trituration. Sublime by a suitable apparatus into a chamber of such size that the calomel, instead of adhering to its sides as a crystalline crust, shall fall as a fine powder on its floor. Wash this powder with boiling water until the washings cease to be darkened by a drop of sulphide of ammonium. Finally, dry at a heat not exceeding 212°, and preserve in a jar or bottle impervious to light.

10 ounces of sulphate of mercury contains 7 ounces of mercury. This, therefore, is an equivalent quantity in reference to the sulphate, and the addition of this quantity of mercury converts it into a subsulphate ($HgSO_4 + Hg = Hg_2SO_4$), and on heating this with chloride of sodium calomel sublimes, and sulphate of soda remains with the excess of chloride of sodium employed, $Hg_2SO_4 + 2NaCl = 2HgCl + Na_2SO_4$.

A small quantity of corrosive sublimate is always formed in the process, hence the necessity of thoroughly washing the calomel; a mere trace of the former is detected by sulphide of ammonium. Pure calomel cannot be sublimed without the formation of a little perchloride.

Care must be taken with the latter part of the process, in order to obtain the calomel of a white colour, and in the state of an impalpable powder. To effect this, Mr Jewell kept the vessel into which the calomel was sublimed full of water or of steam, by which Jewell's *patent calomel* and Howard's *hydro-calomel* were obtained. The apparatus was improved by Henry of Paris, and has been generally adopted, being admitted into the French Codex to produce the "*Calomel à la vapeur.*" Many English chemists have long been in the habit of subliming the calomel into a large chamber full of air; and this method is prescribed in the Pharmacopœia.

Calomel may also be obtained in a state of fine division by precipitation, as in the old Dublin Pharmacopœia, though the sublimed kind is preferred. This is called *Scheele's calomel*, and by the French, *Précipité blanc.* It may be prepared by mixing solution of mercurous nitrate ($HgNO_3$) and chloride of sodium, and washing well the calomel, which is precipitated,

$$2HgNO_3 + 2NaCl = 2HgCl + 2NaNO_3.$$

Characters and Tests.—A dull white, heavy powder; sp. gr. 7·2; nearly tasteless; rendered yellowish by trituration in a mortar; insoluble in water, spirit, or æther. Digested with solution of potash, soda, or lime, it becomes black (from conversion into suboxyde, ($2KHO + 2HgCl = 2KCl + H_2O + Hg_2O$), and the clear solution (of KCl), acidulated with nitric acid, gives a copious white precipitate (AgCl) with nitrate of silver. In contact with solution of ammonia, chloride of ammonium and a black insoluble compound, in which two atoms of mercury displace two atoms of the hydrogen of chloride of ammonium, are formed: $2HgCl+2H_3N=H_4NCl+H_2Hg_2NCl$. Contact with hydrocyanic acid also darkens calomel (from the reduction of mercury in state of fine subdivision). It is entirely volatilised by heat, beginning to sublime before the salt fuses, and condenses in quadrilateral prisms with pyramidal ends (fig. 47). The crystals when scratched exhibit a corresponding yellow mark, and form a white powder with a faint yellowish tinge. Even when pure calomel cannot be sublimed without the formation of a little corrosive sublimate, the following tests are therefore important:—warm æther, which has been shaken in a bottle with calomel, should leave on evaporation no residue of perchloride or red oxyde, both of which are soluble in æther; and again, water with which calomel has been washed gives none of the reactions of corrosive sublimate.

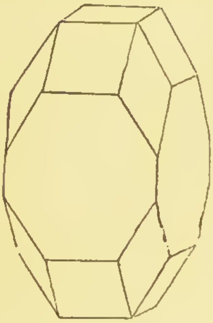

Fig. 47.

Adulterations.—Calomel is not adulterated in England, but it is stated that white precipitate mixed with sulphate of baryta has been sold as calomel on the Continent, and that calomel is sometimes mixed with the latter. All non-volatile impurities are detected as residue after sublimation.

Incompatibilities.—Alkalies and their carbonates; lime water. Sulphuric acid does not act on calomel; solution of chlorine converts it into corrosive sublimate. Precipitated calomel absorbs ammoniacal gas, forming H_3HgNCl—ammonic chloride with an atom of hydrogen displaced by 1 of mercury. Boiled with nitric or hydrochloric acid, or solutions of the chlorides of the alkalies, but especially ammonic chloride, it is decomposed with the formation of corrosive sublimate. Hydrocyanic acid precipitates metallic mercury.

Action and Uses.—Alterative, stimulant, cholagogue, cathartic, anthelmintic, antiphlogistic, and antisyphilitic. In inflammatory affections, such as iritis and pleuritis, it is important to induce mercurialism as speedily as possible, and this is done more readily with calomel than with blue pill, provided the cathartic action of the drug can be prevented. This is commonly effected without difficulty by combining it with opium.

When given in doses of 1 or 2 grains every night as an alterative, in hepatic disease or tertiary syphilis for example, a brisk aperient should be given every second or third morning.

Calomel may very usefully be combined with squills, digitalis, and antimony, as well as opium, for it increases the special effects of these drugs, and at the same time appears to exercise a sedative influence.

Dose.—As an alterative, 1 to 2 grains; as a cathartic, from 3 to 10 grains. Mercurialism may be rapidly induced by 2 grains combined with $\frac{1}{4}$ grain of opium two or three times a day. In delicate persons $\frac{1}{3}$ to 1 grain is usually sufficient for this purpose. In tropical countries large doses (10 to 20 grains) are commonly given, and a sedative influence has been attributed to them.

1. **Pilula Hydrargyri Subchloridi Composita**, *P.B.* *Compound Calomel Pill. Plummer's Pill.*

5 grains contain 1 grain of calomel.

Preparation.—Triturate 1 ounce each of *subchloride of mercury* and *sulphurated antimony* together, add 2 ounces of *guaiacum resin* in powder, and 1 ounce or sufficient of *castor oil*, and beat into a uniform mass.

By long keeping these pills become partially decomposed, sulphide of mercury and chloride of antimony being formed.

Action. Uses.—Alterative and diaphoretic in doses of 5 grains; in larger doses (20 grains), cathartic. Dr Plummer said of his pill, that it is in vain to look for its beneficial effects unless the materials are well levigated together, and for a considerable time.

2. **Unguentum Hydrargyri Subchloridi**, *P.B.* *Ointment of Subchloride of Mercury. Calomel Ointment.*

Composed of 80 grains of *calomel*, mixed with 1 ounce of *prepared lard.*

Calomel ointment is of great benefit in parasitic and syphilitic diseases of the skin. *Pommade de Mercure doux* is made with 1 or 2 parts calomel to 8 of lard, to which some oil may be added.

HYDRARGYRI PERCHLORIDUM, *P.B.* *Perchloride of Mercury.*

$HgCl = 135{\cdot}5$ or $HgCl_2 = 271$.

Bichloride of Mercury. Mercuric Chloride. Corrosive Sublimate. F. *Deuto- and Bi-chlorure de Mercure. Sublimé corrosif.* G. *Doppelt Chlorquecksilber.*

Contains in 100 parts, **Hg** 73·8 and **Cl** 26·2.

Corrosive sublimate has been long known to, and prepared by, the Hindoos, being their *ruskapoor* (Hind. Med. p. 45). It seems also to have been known to the Chinese, and it was prepared by Geber in the eighth century. It is largely manufactured for use both in medicine and the arts.

Preparation.—Reduce 20 ounces of *sulphate of mercury*, 16 ounces of dried *chloride of sodium*, and 1 ounce of *black oxyde of manganese* separately to fine powder, then mix them thoroughly, and put the mixture into a suitable apparatus, and sublime: $HgSO_4 + 2NaCl = HgCl_2 + Na_2SO_4$.

As in the preparation of the subchloride, an excess of chloride of sodium is used, and binoxyde of manganese is employed, to secure the complete oxydation of the sulphate of mercury, and to facilitate the separation of the chlorine, thus preventing the formation of any subchloride. The perchloride sublimes at 509°, and the sulphate of soda and excess of chloride of sodium remain.

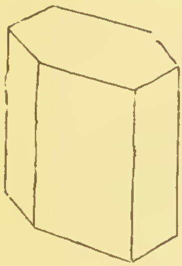

Fig. 48.

Characters and Tests.—In heavy (sp. gr. 5·4), colourless masses of prismatic crystals (fig. 48) possessing a highly acrid metallic taste; soluble in 16 parts of cold, and less than 3 parts of boiling water; separating from hot saturated solutions in transparent anhydrous 4-sided prisms. Very soluble in solutions of the alkaline chlorides which form double salts with it more stable in solution than the chloride alone. Soluble in a little more than 2 parts of cold and in 1 part of hot alcohol; still more soluble in æther, which may be employed to abstract it from an aqueous solution. The aqueous solution reddens litmus, and is gradually decomposed by exposure to light, calomel being precipitated; gives a yellow precipitate (HgO) with caustic soda, potash, or lime; a white precipitate (H_2HgNCl) with ammonia, and a curdy white precipitate ($AgCl$) with nitrate of silver. When heated it sublimes without decomposition, condensing in snow-white needles or rectangular based octohedra, and leaving no residue.

The reactions of the perchloride may be taken as typical of the salts of mercury (see p. 265).

The action of vegetable and animal substances on corrosive sublimate is of considerable importance in reference to poisoning. Most of the vegetable infusions and decoctions in use as medicines, as well as ordinary articles of diet, decompose it, especially when exposed to the action of light; the perchloride also is decomposed when triturated with many fatty or volatile oils, or boiled with sugar. Solutions of animal or vegetable albumin form with corrosive sublimate a white flaky precipitate, which is a definite albuminate of mercury, $HgC_{72}H_{110}N_{18}SO_{22},H_2O$, insoluble in water, but soluble in a solution of chloride of sodium. On account of this reaction, corrosive sublimate is a powerful antiseptic, and it is used as a preservative fluid (1 part to 60 of water) for anatomical preparations, and to prevent the decay of wood and hempen fabrics which are exposed to the joint influence of air and moisture. It also effectually protects them against the attacks of insects and vegetable mould.

Incompatibilities.—Alkalies and their carbonates, lime water, soap, tartar emetic. Salts of silver and lead, iodide of potassium, sulphide of potassium, the more oxydisable metals, vegetable infusions, containing gallo-tannic acid, or albumin; solutions of albumin and gelatin.

Action. Uses.—A violent corrosive irritant poison, in doses of a few grains, producing depression of the nervous system. In medicinal doses, an alterative in syphilis and chronic skin and liver diseases. It rarely produces ptyalism, but is apt to cause anorexia, nausea, griping, and diarrhœa. It has no advantage over the iodide. Applied in substance to moist surfaces, corrosive sublimate is caustic. A strong solution (40 grains to a fluid ounce) produces violent irritation of the skin and subcutaneous tissue, with great swelling, and when applied to the scalp of a delicate child has been known to cause death. A much milder solution (10 grains in 1 ounce) retained in contact with mucous surfaces or the more delicate parts of the skin causes similar effects. It is efficacious in the destruction of pediculi and vegetable parasites. A solution containing 3 grains in the ounce may be safely used by means of a piece of soft rag, even in thrush, the mouth being carefully rinsed after the application.

Dose.—$\frac{1}{16}$ to $\frac{1}{6}$ of a grain in aqueous solution, as the following:—As a lotion, $\frac{1}{2}$ to 2 grains in 1 ounce of water.

1. **Liquor Hydrargyri Perchloridi,** *P.B. Solution of Perchloride of Mercury.*

1 fluid drachm contains $\frac{1}{16}$ of a grain.

Composed of 10 grains each of *perchloride of mercury* and *chloride of ammonium* dissolved in 1 pint of *water.*

Chloride of ammonium is added to prevent decomposition of the solution of corrosive sublimate, which would otherwise slowly result under the influence of light. If the salts existed in the proportion of 32 parts of the former to 27 of the latter, a double salt, *sal alembroth* ($6H_4NCl,HgCl_2,H_2O$), would be formed.

Dose.—15 minims ($=\frac{1}{64}$ gr.) to 2 fluid drachms ($=\frac{1}{8}$ gr.) in chloroform water or some aqueous infusion. This is a safe and convenient way of prescribing corrosive sublimate.

Antidotes.—Albumen, as in the white of eggs, followed immediately by infusion of galls or of catechu; milk, wheat, barley, or bean flour, oak bark, sulphide of iron if administered immediately, or within 15 minutes after the poison has been swallowed; iron filings. Of the chemical antidotes albumen is by far the best; the white of one egg is sufficient to neutralise or render insoluble about 4 grains of the perchloride.

HYDRARGYRUM AMMONIATUM, *P.B. Ammoniated Mercury.*

$H_2NHg_2Cl = 251{\cdot}5$ or $H_2NHgCl = 251{\cdot}5$.

Hydrargyri Ammonio-Chloridum. White Precipitate. F. *Chlorure Ammoniaco-Mercuriel insoluble.* G. *Weisser Quecksilber präcipitat.*

This is chloride of ammonium, in which 2 atoms of hydrogen are displaced by the biequivalent atom of mercury.

This salt was discovered by Raymond Lully in the thirteenth century, and is formed by precipitating a solution of perchloride of mercury by ammonia.

Preparation.—Dissolve 3 ounces of *perchloride of mercury* in 3 pints of *water* with the aid of moderate heat, add to this 4 fluid ounces of *solution of ammonia*, constantly stirring; collect the precipitate on a filter, and wash it well with cold water until the filtrate ceases to give a precipitate when dropped into a solution of nitrate of silver acidulated by nitric acid. Dry the product at a temperature not exceeding 212°.

In this reaction chloride of ammonium, and chloride of ammonium in which two atoms of hydrogen are displaced by one of mercury, are formed. The former remains in solution, and the latter falls as white precipitate: $HgCl_2 + 2H_3N = H_4NCl + H_2NHgCl$. The latter is washed until all traces of chloride are removed. An excess of ammonia is provided for in the above process, and it must be secured throughout by adding the mercurial solution to the ammonia, and not in the reverse order, otherwise a totally different compound (*mercuramine chloride*, see below) will be formed. Inspection of the above formula might lead to the inference that the white precipitate is composed of a molecule of calomel occupying the place of an atom of hydrogen in ammonia, but that this is not a correct view of the composition of ammoniated mercury appears to be proved by the fact that it is soluble in both nitric and hydrochloric acids.

Characters and Tests.—An opaque white powder, on which cold water, alcohol, and æther have no action. Boiled with water it is decomposed into insoluble canary-yellow mercuramine chloride, and chloride of ammonium, $4H_2HgNCl + 2H_2O = H_4Hg_4N_2Cl_2 + 2H_4NCl$. Completely soluble in nitric and hydrochloric acids (absence of calomel), without effervescence (absence of carbonates). Digested in caustic potash it does not blacken (also proving absence of calomel), evolves ammonia, acquires a pale yellow colour (formation of mercuric oxyde), and the fluid filtered and acidulated with nitric acid gives a white precipitate with nitrate of silver (chloride of potassium being formed). Boiled with a solution of chloride of tin, grey globules of metallic mercury (see salts of mercury, p. 265) are formed. Entirely volatilised at a heat under redness.

Adulterations.—This last-mentioned test at once detects such adulterations as chalk, white lead, and the sulphates of lime and baryta, with which ammoniated mercury is commonly mixed. Chalk is the commonest diluent. Starch has been employed; it would char on the application of heat, and be easily recognised by the microscope and iodine water. If improperly prepared, a compound known as *fusible white precipitate* ($H_6HgN_2Cl_2$) may be formed. Unlike the proper compound, it fuses before it is volatilised.

Incompatibilities.—Acids, alkalies, acid and metallic salts.

Action. Uses.—Those of other mercurials. It is very much milder than the perchloride, but it is only used externally, as the following:—

1. **Unguentum Hydrargyri Ammoniati**, *P.B. Ointment of Ammoniated Mercury. White Precipitate Ointment.*

Composed of 62 grains *ammoniated mercury*, mixed with 1 ounce of *simple ointment*.

Action. Uses.—Alterative stimulant in cutaneous diseases and indolent ulcers, especially of a syphilitic or parasitic nature.

SULPHIDE OF MERCURY. *Vermilion.*

$HgS = 116$ or $\mathbf{HgS} = 232$.

Mercuric Sulphide. Cinnabar. F. *Sulfure rouge de Mercure.* G. *Rothes Schwefelquecksilber.*

Cinnabar was known to the Greeks. It was employed as a pigment by the Egyptians. The Chinese as well as the Hindoos have from early times employed it as a medicine, and the former have long been celebrated for their *vermilion.* It was formerly called *kinnabara* and also *minium*, being often confounded with the red oxyde of lead. It occurs native, both massive and crystallised, and is the principal ore from which the metal is extracted at Idria, Almaden, and in China. It is prepared artificially for use both in medicine and the arts.

Preparation.—Most of the vermilion of commerce is prepared in Holland by the following process:—1 part of *sulphur* is triturated with 6 parts of *mercury* by the aid of a gentle heat, a black mass of imperfectly formed sulphide is thus formed, and it is thrown in small portions into tall earthen jars, the lower parts of which are red hot; after the whole has been introduced, the aperture of the jar is closed with an iron plate, and in about thirty hours the sublimation is complete. The cinnabar which is deposited on the upper parts of the pots is detached and levigated with water.

Properties.—When in substance it is of a dark-red colour, heavy, striated, giving a bright red streak when scratched; but when powdered is of a brilliant red, and commonly called *vermilion.* Sp. gr. 8·1. It is devoid of both taste and odour; is insoluble in water and alcohol, and in acids, except in aqua regia, which converts into sulphate; and unalterable in the air. Heated, it becomes of a brownish-red or black, and in the air burns with a blue flame, yielding sulphurous anhydride and metallic mercury; but it sublimes unchanged in closed vessels. Heated with potash, globules of mercury are produced, and the addition of hydrochloric acid causes the evolution of hydrosulphuric acid.

Adulterations and Impurities.—Red lead has been employed for this purpose, it remains after sublimation of the sulphate, and forms a soluble salt of lead with acetic acid.

Action. Uses.—Inert when given by the stomach; but when used as a fumigation the constitutional effects of mercury, and the local effects of sulphurous acid, are induced. It is employed as a fumigation in chronic syphilitic skin diseases. It is much employed by the Hindoos.

Dose.—For fumigation, about 30 grains.

Hydrargyri Sulphuretum cum Sulphure of the old L. P., also called *Ethiops mineral*, is black subsulphide ($\mathbf{Hg_2S}$) with excess of sulphur. It was made by rubbing together equal parts of mercury and sulphur until globules were no longer visible. It is an inert preparation, and now quite obsolete.

HYDRARGYRI SULPHAS, *P.B.* *Sulphate of Mercury.*

$HgO,SO_3 = 148$ or $HgSO_4 = 296$.

Mercuric Sulphate. F. *Deuto-Sulphate de Mercure.* G. *Schwefelsaures Quecksilberoxyd.*

Preparation.—Heat 20 ounces by weight of *mercury*, with 12 fluid ounces of *sulphuric acid*, in a porcelain vessel, stirring constantly until the metal disappears, then continue the heat until a dry white salt remains.

An atom of mercury displaces the hydrogen of two molecules of sulphuric acid, and unites with 1 molecule of the latter to form sulphate, while the remaining molecule is deoxydised by the liberated hydrogen and converted into sulphurous anhydride, which is evolved in great abundance: $Hg + 2H_2SO_4 = HgSO_4 + 2H_2O + SO_2$.

Characters and Tests.—A white crystalline, heavy (sp. gr. 6·46) powder, soluble in solution of chloride of sodium; rendered yellow by affusion of water, being converted into an insoluble basic sulphate ($HgSO_4,2HgO$) called turbith mineral, and a soluble acid salt which crystallises in deliquescent needles. The sulphate is entirely volatilised by heat.

Action.—A violent corrosive poison like the chloride. It is not used internally.

Pharmaceutical Uses.—The preparation of the subchloride and perchloride, and the following non-officinal salt of mercury.

Yellow Subsulphate of Mercury. *Turbith* or *Turpeth Mineral.*

$HgO,SO_3 + 2HgO$ or $HgSO_4 2HgO$.

Prepared by washing finely levigated sulphate in hot water until the washing no longer precipitates chloride of barium.

Action and Uses.—This is one of the most active of the salts of mercury. It causes vomiting and purging, and, if its action be controlled by opium, small doses induce ptyalism. The powder excites sneezing.

Dose.—As an alterative, $\frac{1}{4}$ to 1 grain; as an emetic and purgative, 2 to 5 grains; as an errhine, $\frac{1}{2}$ grain mixed with a pinch of dry snuff or starch powder.

LIQUOR HYDRARGYRI NITRATIS ACIDUS, *P.B.*

Acid Solution of Nitrate of Mercury, or *Mercuric Nitrate.*

HgO,NO_5 or $Hg2NO_3$, in excess of nitric acid.

Preparation.—Dissolve 4 ounces of *mercury* in 5 fluid ounces of *nitric acid*, diluted with $1\frac{1}{2}$ ounce of *water*, without the aid of heat. Then boil gently for fifteen minutes, cool, and preserve the solution in a stoppered bottle.

As in the case of sulphuric acid, the mercury displaces the hydrogen of the acid, and the liberated hydrogen deoxydises another portion of acid, forming water and nitric oxyde which is evolved in great abundance: $3Hg + 8HNO_3 = 3(Hg2NO_3) + 4H_2O + 2NO$.

There are a variety of nitrates of mercury, their composition depending on the strength of the acid and the temperature at which the solution is effected. It is assumed that a normal mercuric nitrate is formed in the above process; but a more certain method of obtaining a salt of this exact composition is to add an excess of red oxyde to nitric acid diluted with an equal bulk of water, and evaporate the clear liquid to a syrupy consistence, when large transparent crystals are slowly formed.

Characters and Tests.—A colourless and strongly acid solution, of sp. gr. 2·246, which gives a yellow precipitate with solution of potash (HgO, indicating a protosalt of mercury). If a crystal of sulphate of iron be dropped into it, in a little time the salt of iron, and the liquid in its vicinity, acquires a dark colour (for explanation of this reaction, see p. 73). Does not give any precipitate when a little of it is dropped into hydrochloric acid diluted with twice its bulk of water (absence of subsalt, which, on admixture with the acid, would be precipitated as calomel).

Action. Uses.—A caustic application to syphilitic warts, mucous tubercles, lupus exedens, and to cancerous affections of the os and cervix uteri and to phagedenic ulcers. It should be applied by means of a glass brush or pipette. When extensively used it is liable to produce salivation. The surrounding parts must be protected from contact, as it is a painful application.

1. **Unguentum Hydrargyri Nitratis,** *P.B. Ointment of Nitrate of Mercury. Unguentum Citrinum. Citrine Ointment.*

Citrine ointment is a much-used and highly valued application. It is prepared as follows:—

Preparation.—Dissolve 4 ounces of *mercury* in 12 fluid ounces of *nitric acid* with the aid of a gentle heat; melt 15 ounces of *prepared lard* in 32 fluid ounces of *olive oil* by a steam or water bath, in a porcelain vessel capable of holding six times the quantity; and, while the mixture is hot, add the solution of mercury, also hot, mixing them thoroughly. If the mixture do not froth up, increase the heat till this occurs. Keep it stirred until it is cold.

A solution of nitrate of mercury, but in a larger excess of acid, is thus formed as in the previous preparation. When this is mixed with hot oleaginous matter, strong chemical action, attended with much swelling and a copious disengagement of the lower oxydes of nitrogen, ensues. The nitric oxyde retained in the solution of nitrate of mercury, and the latter both decompose the olein and convert it into an isomeric but solid fat (*Elaidin*). A little red viscid oil, soluble in alcohol, is also formed by the action of the free nitric acid, and it is this which gives the ointment its lemon colour.

Characters.—When properly prepared, this ointment is of a bright lemon colour, has the consistence of lard, and an unpleasant nitrous odour. After a month or two it becomes firmer, and then hard, lumpy, and almost powdery. When kept too long, and exposed to light, the colour becomes dull, and greenish or greyish from slow reduction of the mercury. Contact with steel causes the immediate precipitation of mercury; a wooden spatula must therefore be used with this ointment.

Incompatibilities.—Ointments of antimony, cadmium, iodine, lead, sulphur, and zinc. The more oxydisable metals, as iron.

Action. Uses.—A stimulant and alterative application to the eyelids in chronic ophthalmia, also in several cutaneous eruptions of a parasitic nature, and to foul and indolent ulcers. If long applied, it will produce mercurialism. When decomposition has taken place, it ought not to be applied, as it then becomes extremely irritant. It is rarely necessary to employ the undiluted ointment; the Unguentum hydrargyri nitratis mitius of a former Pharmacopœia (composed of 1 part of the above mixed with 7 parts of prepared lard) is the more suitable form. By the addition of olive oil it may be made into a semifluid state, in which it is best adapted for application to the margin of the eyelids.

Hydrargyri Acetas. *Sub-Acetate of Mercury. Mercurous Acetate.*

$Hg_2O,C_4H_3O_3$ or $\mathbf{HgC_2H_3O_2}$.

Was introduced into practice in consequence of the French Government having, in the middle of the last century, purchased the secret of *Keyser's pills*, which were vaunted as an anti-syphilitic remedy. The acetate may be made by mixing hot solutions of subnitrate of mercury and acetate of potash. Double decomposition takes place, and the acetate of mercury, being comparatively insoluble, crystallises out as the solution cools. It occurs in thin scale-like crystals, flexible, white in colour, without odour, but having an acrid metallic taste. Sparingly soluble in cold, and partially decomposed by boiling water, and also by boiling alcohol. Light decomposes and blackens it. Heat resolves it into acetic and carbonic acids and mercury. Sulphuric acid disengages acetic acid, and the alkalies precipitate the black oxyde of mercury from its solutions, and thus distinguish it from acetate of the peroxyde.

Action.—It is considered a mild mercurial, but has occasionally acted with violence, in consequence probably of being badly prepared, or having afterwards altered in composition.

Dose.—1 to 5 grains.

Hydrargyri Cyanidum. *Cyanide of Mercury.*

$HgC_2N=126$ or $\mathbf{Hg2Cy=252}$.

Was discovered by Scheele. It is not now officinal in any of the Pharmacopœias. It may be prepared by saturating the officinal dilute hydrocyanic acid with oxyde of mercury, and evaporating, that crystals may form. The cyanide crystallises in anhydrous obliquely truncated four-sided prisms; colourless, of a disagreeable metallic taste, permanent in the air, partially dissolved by alcohol; soluble in eight times their weight of cold, but much less of boiling water. Hydrochloric acid disengages hydrocyanic acid. Heated, it is resolved into cyanogen and metallic mercury.

Action and Uses.—It is an irritant poison. Sometimes used as a substitute for corrosive sublimate, which it resembles in action, but over which it has the advantage of being compatible with the alkalies and organic matters.

Dose.—$\frac{1}{16}$th gradually increased to $\frac{1}{2}$ grain, in pills or in solution.

ARSENICUM: As=75 or **As**=75.

Arsenic. F. *Arsenic.* G. *Arsenik.*

The name arsenic is ambiguous even now, being applied sometimes to the metal, and sometimes to one of the compounds which this forms with oxygen (white arsenic, or arsenious acid). The same ambiguity occurs in old works; for the name *arsenikon* (ἀρσενικὸν) is applied by Dioscorides to the yellow sulphide, while the red sulphide is distinguished by the name *sandarach* (σανδαράχα). The Arabs call the former *zurneekh zurd* (yellow), and the second *zurneekh zoorkh* (red). The name *zurneekh* is supposed by Sprengel to be a corruption of arsenicon, but of this there is no proof. The Arabs were also acquainted with the white oxyde, which they called *sum-al-far*, *mouse-poison*, or ratsbane, and also *shook*, *turab-al-hulk*, and *turab-al-kai*, windpipe-earth, and emetic-earth. The Hindoos are well acquainted with all three substances; orpiment being their *hurtal*, realgar their *mansil*, while white arsenic they call *sanchya.* They were probably the first to prescribe it internally, as in leprosy (Prof. H. H. Wilson), which they still do, both in that complaint and in intermittent fevers. Metallic arsenic was first distinctly made known in Europe by Brandt in 1733. Geber seems to have been acquainted with it.

Arsenic is sometimes found native in a metallic state, but it is most extensively diffused in combination with other metals, as in the arsenides of iron, nickel, copper, cobalt, &c. It is separated from these metals by roasting in a reverberatory furnace, and collecting what is sublimed in a long horizontal chimney, or into one divided into numerous compartments. By this process of roasting the metallic arsenic is separated and oxydised, being converted into arsenious acid (As_2O_3). This, being in an impure state, is first purified by sublimation, and then heated with charcoal, which abstracts the oxygen, and reduces the arsenic to its metallic state, and enables it to be separated by sublimation.

Pure metallic arsenic is prepared by covering arsenious acid with charcoal, in a German glass tube, and subliming the metal into the cool or distant end of the same tube.

Properties.—Metallic arsenic is of a steel-grey colour, has a metallic lustre, is isomorphous with antimony, crystallising in confused rhombohedra; it is very brittle; sp. gr. 5·8. Heated in close vessels it readily sublimes at a low red heat, and is again deposited in a bright metallic crust, shining like polished steel. Its vapour is remarkable for having a strong odour of garlic. Exposed to moist air it tarnishes, and becomes encrusted with a grey powder, a mixture of arsenious acid and metallic arsenic. It is readily oxydised also in water, and even in alcohol. Heated in the air, arsenic easily burns, producing white fumes of oxyde, that is, of arsenious acid, sometimes called flowers of arsenic.

Arsenic is an acidifiable metal, *i.e.*, it tends to form with oxygen acids, and not bases. Two distinct oxydes or acids exist:—1. Arsenious acid (which is officinal), As_2O_3. 2. Arsenic acid, As_2O_5, two salts of which are officinal.

Characters of the Compounds of Arsenic.—1. *A garlic odour* (due to metallic arsenic) when heated in the reducing flame of the blowpipe with sodic carbonate on charcoal.

2. *The reduction and sublimation of metallic arsenic.* This is readily affected by the following process:—

A tube, the size of a crow quill, closed at one end, should be used; a fragment of the arsenious compound is first dropped in, then a minute quantity of dried sodic carbonate, and upon this a little powdered charcoal; or the arsenical compound may be mixed with three times its bulk of black flux and placed in the tube, on igniting the mixture in the blowpipe flame (fig. 49), the metal is sublimed and forms a brilliant steel-grey ring around the cooler portion of the tube. The $\frac{1}{300}$th of a grain of arsenicum is thus rendered visible.

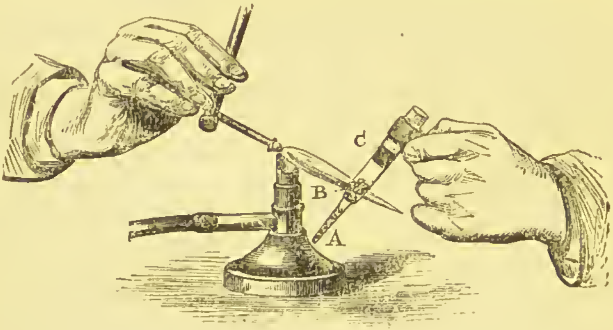

Fig. 49.

3. *The metal may be converted by sublimation in a current of air into arsenious acid.* In order to effect this, break off the sealed end of the tube, and by the application of the flame of the spirit-lamp to the part containing the metallic film, chase this along the tube until it sublimes as a white or crystalline deposit. Under a low power of the microscope it will be seen to be composed of brilliant octohedra of the regular form (fig. 50). If the crystals be very

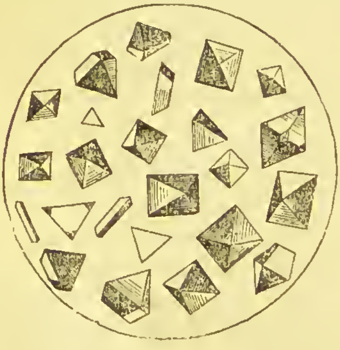

Fig. 50.

minute and imperfect, heat the contiguous parts of the tube and sublime the deposit again. The condensation taking place now on a warm surface, the arsenious acid forms a sparkling deposit of larger crystals, the form of some of which may be recognised by the aid of a pocket lens. The portion of tube containing the deposit may be now isolated and boiled in water, and the *solution of arsenious acid will then give the following reactions:*—1. With *ammonio-nitrate of silver* a canary-yellow precipitate* (Ag_3AsO_3) of triargentic arsenite, soluble in both ammonia and nitric acid. 2. With *ammonio-sulphate of copper* an emerald-green precipitate ($CuHAsO_3$), also soluble in ammonia and acids. 3. Acidulated with hydrochloric acid, *sulphuretted hydrogen* causes a gamboge-yellow precipitate of sesquisulphide (As_2S_3); if the solution be very dilute, a portion remains dissolved in the liquid, giving to it a yellow colour; on exposure to warm air for a few hours the excess of sulphuretted hydrogen escapes, and the whole of the arsenious sesquisulphide is precipitated. In order to examine this further, decant the fluid and collect the precipitate on a small filter, dissolve it by a few drops of ammonia, and wash the solution out of the filter, evaporate it to dryness in a small capsule over a water bath. Collect the yellow sesquisulphide, mix it with thrice its bulk of black flux, and proceed as directed above for the reduction of the metal; oxydise the metal and obtain octohedra of arsenious acid.

When the solution contains arsenic acid, a stream of sulphuretted hydrogen must be allowed to flow through it for six hours, for the arseniates are only slowly decomposed by sulphuretted hydrogen. If the arsenical compound be contained in organic fluids, such as the contents of the stomach, the arsenic may be detected and isolated by two methods, those of Reinsch and Marsh.

Reinsch's test is thus applied:—Acidulate the fluid with $\frac{1}{10}$th of its bulk of *pure* hydrochloric acid, and boil with pure electrotype copper foil; the copper rapidly becomes grey as it receives a coating of metallic arsenic. Remove from the mixture, wash, and dry by the water bath, and then place it in a glass tube the diameter of a goose quill, and closed at one end. The foil is then strongly heated when the metal is volatilised, and combining with the oxygen of the air, condenses in octohedra of arsenious acid in the cooler parts of the tube.

Antimony and mercury are also readily reduced upon copper by the above method, but the mercurial deposit is composed of minute globules, and when rubbed on the copper form a smooth amalgam with it. Antimony is oxydised like arsenic, but the antimonious oxyde sublimes with difficulty in needles. As these, however, are isomorphous with the uncommon form of arsenious acid, a further examination is needed; the tube should be boiled in a little water, acidulated with a drop of hydrochloric acid, the solution neutralised

* The tribasic phosphates give a canary-yellow precipitate with ammonio-nitrate of silver.

with ammonia, and then tested with ammonio-nitrate of silver and ammonio-sulphate of copper.

Marsh's test consists in the formation of arseniuretted hydrogen and the separation of the metallic arsenic therefrom by the application of heat. It is thus applied:—Take a 4 or 6 ounce flask containing a little pure granulated zinc, and fitted with a cork carrying a funnel to the bottom, and a chloride of calcium tube with a piece of German glass drawn out at one end into a point to form a burner, and united by means of a piece of India-rubber tubing at the other end with the chloride of calcium tube. Introduce water and then a little pure sulphuric acid into the flask by means of the funnel, and when the hydrogen has chased out the air, heat the German tube to redness by means of a spirit-lamp for ten minutes. If no metallic deposit be formed, the zinc and acid are pure, and a little of the fluid containing arsenic may now be poured in, the tube being maintained red hot as before. Arseniuretted hydrogen is immediately formed, and a steel-grey ring of metallic arsenic is quickly deposited just in front of the hot part of the tube. If now the gas be kindled at the orifice of the burner, it burns with a bluish-white flame, and as often as the flame is depressed by a cold porcelain plate, metallic arsenic is reduced in the form of a grey spot. Marsh's apparatus (fig. 51) may be employed instead of the above, but it ought never to be used a second time. It is best to proceed as above directed.

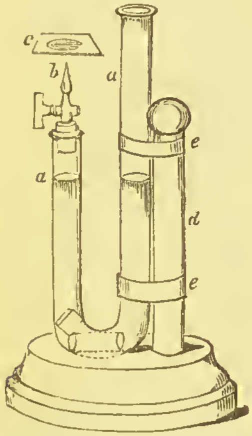

Fig. 51.

Antimoniuretted hydrogen behaves in the same way, but it may be distinguished by ammonic sulphide which forms with the antimony stain the orange-coloured antimonious sesquisulphide, but scarcely affects the arsenical film (Dr Guy). To prevent inconvenient frothing of certain organic fluids, they should be previously boiled with $\frac{1}{10}$th their bulk of pure hydrochloric acid, adding a few crystals of potassic chlorate.

ACIDUM ARSENIOSUM, *P.B.* *Arsenious Acid.*

$AsO_3 = 99$ or $As_2O_3 = 198$.

Arsenicum Album. White Arsenic. Arsenious Sesquioxyde. Arsenious Anhydride. F. *Arsenic blanc.* G. *Weisser Arsenic. Arsenichtesaure.*

Arsenious acid is found native, but is almost always obtained from the arsenical ores mentioned under Arsenicum.

It is prepared in Silesia and in Cornwall by roasting mispickel or arsenical iron pyrites ($FeAsS$). As_2O_3 sublimes, and sulphide of iron remains. The product is purified by a second sublimation in iron vessels with conical heads. It is then sufficiently pure, and rarely needs a further sublimation.

Characters and Tests.—A heavy (sp. gr. 3·7) white powder, or in sublimed blocks, which usually present a stratified appearance caused by the existence of separate layers differing from each other in degrees of opacity. It occurs in the vitreous and crystalline forms, and when freshly prepared the whole mass has a lamellated vitreous appearance, but the layers gradually become alternately crystalline, and milk-white like enamel or porcelain, and some of the latter often assume on exposure a yellow tinge. It is tasteless, but leaves a faint sweetish after-impression. It is sparingly soluble in water,* the crystalline variety being nearly three times more soluble than the opaque (Bussy). By prolonged boiling the opaque becomes converted into the crystalline form, and increases in solubility. At 212° water dissolves between 11 and 12 per cent. of the crystalline form, and retains from 2 to 3 per cent. on cooling. Arsenious acid is also slightly soluble in alcohol. The aqueous solution reddens litmus, gives with ammonio-nitrate of silver a canary-yellow precipitate (Ag_3AsO_3), insoluble in water, but readily soluble in ammonia and in nitric acid; with ammonio-sulphate of copper, an emerald-green precipitate of arsenite of copper ($CuHAsO_3$), also soluble in nitric acid and in ammonia. Heated to 380° it sublimes without fusing; the vapour is colourless and odourless, and condenses on a warm surface in brilliant regular octohedra, and occasionally in prismatic needles isomorphous with those of oxyde of antimony (Sb_2O_3). If minute portions of arsenious acid and acetate of soda be heated together in a small test-tube, the offensive odour of kakodyle is developed. Heated in a narrow tube with charcoal, or better, black flux, the oxygen is removed and the metal volatilised, emitting a garlic odour, and condensing on the cooler part of the tube as a bright steel-grey film. 4 grains dissolved in boiling water with 8 grains of bicarbonate of soda, discharge the colour of 808 gr. measures of the volumetric solution of iodine, the quantity requisite to convert 4 grains of arsenious acid into arsenic acid ($As_2O_3 + 4I + 2H_2O = As_2O_5 + 4HI$).

As arsenic and most of its compounds are poisonous, and have been much employed both by suicides and murderers, it is necessary to be able to detect their presence. In suspected cases, any powder adhering to the coats of the stomach, or left in the vessels employed, is to be searched for and kept apart; the stomach and its contents may be boiled in distilled water; or the poison may be searched for in the blood and solids of the body, as it is not found in these or the bones naturally, as was at one time thought by Orfila. We may, therefore, have to treat it as a solid substance, or in the state of solution, either pure or intermixed with organic matters. We may often get a ready indication of the presence of arsenic by the processes described under "characters of the compounds of arsenic" (p. 288).

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* Dr Taylor (Guy's Hosp. Reports, vol. iv. p. 83), observing the great discrepancies in the statements of chemists respecting the solubility of arsenious acid, submitted it to careful experiment; and he states that there is no observable difference in the solubility of the transparent and opaque varieties; that water at ordinary temperatures dissolves about $\frac{1}{1000}$th or $\frac{1}{500}$th of its weight, according to circumstances; that hot water at 212°, allowed to cool on it, dissolves less than $\frac{1}{400}$th of its weight, or about $1\frac{1}{4}$ grain to each fluid ounce; but that water boiled for an hour on arsenious acid dissolves $\frac{1}{24}$th of its weight, or rather more than 20 grains to each fluid ounce; and that this water, on cooling, retains $\frac{1}{40}$th of its weight, or 12 grains to the fluid ounce. Arsenious acid readily combines with potash and soda, forming soluble salts, and also with lime and some metallic oxydes, forming insoluble and characteristic compounds, noticed among the tests.

Action and Uses.—Arsenious acid is absorbed and conveyed by the blood into all the tissues of the body, and is of course in greatest abundance in the most vascular parts, viz., the parenchymatous organs, and the skin and mucous membrane. Its ultimate action on these appears to be stimulant, and by increasing the circulation in these parts and improving the tone of the blood-vessels, we may assume that it exercises a beneficial and tonic influence. It is eliminated by the kidneys and liver, and probably also by the alimentary canal. Small quantities of arsenious acid ($\frac{1}{16}$th of a grain) alone, or dissolved in hydrochloric acid, or in combination with alkali, may be taken for a considerable time without producing any obvious effects. It has been stated that the Styrian peasants are constantly in the habit of eating minute portions with the view of improving the complexion (Heisch. Pharm. Jour. 1860, p. 556); and, in this country, arsenious acid has been long given to horses to improve the coat. After a time, or if the dose be increased beyond the limit of toleration, disorder of the digestive organs and of the mucous membrane generally results, indicated by anorexia, dryness of the mouth and throat, thirst, a feeling of warmth, burning or acutal pain in the epigastrium or hypochondrium, flatulency, with colicky pains and a tendency to diarrhœa, redness of the conjunctiva, with swelling of the margins of the eyelids, coryza, and some bronchial irritation. These effects quickly disappear after the medicine is omitted; but if it be continued in increased doses the patient will soon exhibit symptoms of chronic gastro-enteritis; vomiting and purging will be so frequent as to arrest nutrition; there will be great constitutional irritation, with emaciation, and occasionally the eruption of a few pustules on the skin, swelling of the face and falling of the hair, and a dry cough, attended by the following nervous symptoms: insomnia, headache, neuralgic pains, great muscular weakness and trembling, and sometimes convulsions and incomplete paralysis.

In large doses arsenious acid is a powerful irritant poison, causing vomiting and purging, followed by collapse. 2 or 3 grains may cause death, if given in solution on an empty stomach; but an ounce taken after a full meal, and speedily rejected, has caused only trivial effects. It has been occasionally employed as a caustic in cancer and allied affections, but its use as such is both unnecessary and improper,—unnecessary, because it has no advantage over other caustics, such as chloride of zinc; and improper, since arsenious acid is rapidly absorbed by fresh wounds and ulcerated surfaces, and if applied to an extensive surface destroys life. In medicinal doses arsenious acid is stimulant, tonic, antiperiodic, and commonly regarded as antispasmodic. As a *stimulant* to the cutaneous circulation its beneficial effects are marked in chronic eczema, impetigo, and in the hereditary forms of lepra and its varieties. In the congestion of the liver and spleen, which accompanies if it does not cause ague, the tonic stimulant action of arsenic is most marked, and some observers regard it as efficacious in the cure of this disease as quinine. But its influence in ague is certainly neither so certain nor so prompt as that of the cinchona alkaloid.

In certain nervous disorders, especially neuralgia of a periodic character, and chorea, arsenic is a well-tried and approved remedy.

Dose.—$\frac{1}{16}$th to $\frac{1}{8}$th of a grain, in the form of solution (see below).

Antidotes.—If the patient can swallow, and the stomach-pump be not at hand, let him take a quantity of the hydrated peroxyde of iron, in a potable form with milk or water; then induce vomiting as speedily as possible, and wash out the stomach with water in which the peroxyde of iron is suspended. Afterwards give a tablespoonful of the peroxyde in a copious draught of milk. By oxydation of the arsenious acid an insoluble arseniate of iron is formed. If this antidote cannot be readily procured, milk mixed with calcined magnesia may be used in the same way instead. After the evacuation of the stomach, the patient should be brought under the influence of morphia by the subcutaneous injection of $\frac{1}{4}$th of a grain, repeated twice or thrice after an interval of 15 minutes. By this means the absorbent action of the stomach is diminished.

[To prevent arsenic and its compounds from being used in poisoning, the *Act to regulate the Sale of Arsenic* imposes the following restrictions on druggists and retailers. It is provided—

1. That no arsenic shall be sold without an entry being made in a book of the purpose for which it is required—with the date, name, and occupation of the purchaser—to be signed by the purchaser and the seller.
2. That either the purchaser must be known to the seller, or the sale must be made in the presence of a witness known to both, who also must sign the entry. That the purchaser must be of full age.
3. That, unless in a quantity of at least ten pounds, no arsenic shall be sold at all without being first mixed up with soot or indigo, in the proportion at least of 1 ounce of soot or half-an-ounce of indigo to each pound of arsenic.
4. From these regulations, which are enforced under a heavy penalty, the prescriptions of medical men are excepted.

The effect of the *Arsenic Act* has been to compel poisoners to resort to the vegetable kingdom, and use opium, strychnia, chloral hydrate, &c., to control the free sale of which some more stringent legislative enactment appears to be required.]

1. **Liquor Arsenicalis**, *P.B.* *Arsenical Solution. Liquor Potassæ Arsenitis. Fowler's Solution.*

A solution of arsenious acid and arseniate of potash (K_3AsO_3) in water coloured by red sandal wood.

1 fluid ounce contains 4 grains of arsenious acid, partly free and partly combined.

Preparation.—Heat 80 grains each of *arsenious acid* in powder and *carbonate of potash* with 10 fluid ounces of *water* in a flask until they are dissolved. When cold add 5 fluid drachms of *compound tincture of lavender*, and as much water as is needed to make the solution measure 1 pint.

Arsenious acid is soluble in carbonate of potash without decomposition, but chemical combination progresses slowly until the carbonate is converted into tripotassic arsenite, $3K_2CO_3 + As_2O_3 = 2K_3AsO_3 + 3CO_2$. One-half, however, of the arsenious acid is in excess, and remains dissolved in the solution. Tincture of lavender is added merely to give colour.

Characters and Tests.—A reddish liquid, alkaline to test paper, and having the odour of lavender; sp. gr. 1·009. When acidulated with hydrochloric acid, it gives with sulphuretted hydrogen a yellow precipitate (As_2S_3), which is brightest when the arsenical solution has been previously diluted. 441·5 grains (1 fluid ounce) boiled for five minutes with 10 grains of bicarbonate of soda, and when cold diluted with 6 fluid ounces of water to which a little mucilage of starch has been added, does not give with the volumetric solution of iodine a permanent blue colour until 808 gr. measures have been added, corresponding to 4 grains of arsenious acid in 1 fluid ounce, the arsenious acid converting the iodine into colourless hydriodic acid (see p. 79).

Action and Uses.—Those of arsenious acid (see p. 292). This is the best form of arsenic for internal use. It should be prescribed with a little alkali and taken in a full draught of water, in order to avoid the gastric irritation which sometimes ensues in delicate persons if this precaution be omitted. It should be cautiously employed. The patient should be frequently seen, and if gastro-intestinal irritation arise the dose should be reduced or altogether omitted for a time. It is employed in ague, neuralgia, convulsive diseases, especially chorea; in chronic skin diseases, not due directly to syphilis, and as a general stimulant and tonic.

Dose.—3 minims ($=\frac{1}{40}$ grain) to 5 minims ($=\frac{1}{24}$ grain) gradually increased if necessary to 20 minims ($=\frac{1}{6}$ grain), twice or thrice a day.

2. **Liquor Arsenici Hydrochloricus**, *P.B.* *Hydrochloric Solution of Arsenic.*

A solution of arsenious acid in water acidulated with hydrochloric acid. It contains the same quantity of arsenious acid as the Liquor arsenicalis.

Preparation.—Boil 80 grains of *arsenious acid* with 2 fluid drachms of *hydrochloric acid*, diluted with 4 ounces of *water*, until it is dissolved, then add sufficient water to make the solution measure 1 pint.

Arsenious acid dissolves freely in hot hydrochloric acid, and if the solution be boiled arsenic trichloride ($AsCl_3$) is volatilised; but no trichloride exists in the solution, as it is decomposed in the presence of water into arsenious and hydrochloric acids; and when a hot saturated solution in hydrochloric acid cools, unaltered arsenious acid crystallises out. The preparation under consideration must, therefore, be regarded as an acid solution of arsenious acid.

Characters and Tests.—A colourless liquid, having an acid reaction; sp. gr. 1·009. Sulphuretted hydrogen gives at once a bright yellow precipitate (As_2S_3). 441·5 grains by weight (1 fluid ounce) boiled for five minutes with 20 grains of bicarbonate of soda, and then diluted with 6 fluid ounces of distilled water, to which a little mucilage of starch has been added, does not give with the volumetric solution of iodine a permanent blue colour until 808 gr. measures have been added; corresponding to 4 grains of arsenious acid in 1 fluid ounce (so long as any arsenious acid remains unconverted into arsenic acid, the iodine is changed into colourless hydriodic acid, see p. 79).

Action and Uses.—Those of arsenious acid or Liquor arsenicalis. The latter preparation sometimes causes a little irritation of the stomach, and hence it is necessary to give the medicine on a full stomach. In this case the hydrochloric solution is the appropriate one, because its acid is identical with that of the gastric juice.

ARSENIC ACID. *Arsenic Anhydride.*

$AsO_5 = 115$ or $As_2O_5 = 230$.

Contains in 100 parts, As 65·22 and O 34·78.

This is the highest state of oxydation of the metal. It is prepared by dissolving arsenious acid in slight excess of nitric acid, and boiling down to dryness in a platinum vessel. The deliquescent salt remains; crystals of the hydrated acid ($3HO,AsO_5$ or H_3AsO_4) may be obtained by evaporating the aqueous solution. It is freely soluble in water, forming a highly acid and intensely poisonous solution. The acid is tribasic, resembling phosphoric, and forming salts isomorphous with the tribasic phosphates. It decomposes the carbonates and displaces the volatile acids from their combinations. Sulphurous acid reduces a solution of arsenic acid with the formation of arsenious and sulphuric acids, thus:

$$H_3AsO_4 + H_2SO_3 = H_3AsO_3 + H_2SO_4.$$

ARSENIATES.—These salts give a brick-red precipitate (Ag_3AsO_4) with *nitrate of silver;* a pale greenish-blue hydrocupric arseniate ($CuHAsO_4$) with ammonio-sulphate of copper. Both precipitates are soluble in excess of ammonia; and a colourless crystalline precipitate isomorphous with triple phosphate (see p. 66) with ammonio-sulphate of magnesia. The arseniates, like the phosphates, are all soluble in dilute nitric acid.

Two arseniates, those of soda and iron, are used in medicine.

1. **Soda Arsenias,** *P.B. Arseniate of Soda*, or *Hydrodisodic Arseniate.*

$2NaO,HO,AsO_5+14HO$, or $Na_2HAsO_4,7H_2O$.

This salt is similar in chemical constitution to ordinary phosphate of soda.

Preparation.—Reduce separately 10 ounces of dry *arsenious acid*, $8\frac{1}{2}$ ounces of dry *nitrate of soda*, and $5\frac{1}{2}$ ounces of dried *carbonate of soda* to fine powder; mix thoroughly; place the mixture in a large clay crucible, and cover it with the lid. Expose to a full red heat till all effervesence has ceased, and complete fusion has taken place. Pour out the fused salt on a clean flagstone, and as soon as it has solidified, and while it is still warm, put it into boiling water, stirring diligently. When the salt has dissolved, filter the solution and set it aside to crystallise. Drain the crystals, and having dried them rapidly on filtering paper, put them in a stoppered bottle.

The nitrate of soda yielding oxygen to the arsenious acid, converts it into arsenic acid, which expels the carbonic acid of the carbonate and unites with the whole of the base present to form pyroarseniate of soda, isomorphous with the pyrophosphate of that base (see p. 162), carbonic and nitrous acid gases escaping:

$$As_2O_3+Na_2CO_3+2NaNO_3=Na_4As_2O_7+CO_2+N_2O_3.$$

Solution in water converts the pyroarseniate into the ordinary salt:

$$Na_4As_2O_7+H_2O=2Na_2HAsO_4.$$

Characters and Tests.—Colourless transparent prisms, soluble in water. The solution is alkaline, and gives white precipitates with chloride of barium (Ba_32AsO_4), chloride of calcium (Ca_32AsO_4), and sulphate of zinc (Zn_32AsO_4), and a brick-red precipitate with nitrate of silver (Ag_3AsO_4), all of which are soluble in nitric acid. Heated to 300°, it loses 40·38 per cent. of its weight (the water of crystallisation). A watery solution of 10 grains of the residue treated with 53 gr. measures of the volumetric solution of soda continues to give a precipitate with the volumetric solution of nitrate of silver until 1613 gr. measures of the latter have been added (indicating the presence of 10 grains of dry arseniate of soda).

Action and Uses.—Those of arsenious acid and Liquor arsenicalis. It is considered milder than these.

Dose.—$\frac{1}{16}$th to $\frac{1}{8}$th of a grain, given as the following solution:

1. **Liquor Sodæ Arseniatis,** *P.B. Solution of Arseniate of Soda.*

This is prepared by dissolving 4 grains of arseniate of soda (rendered anhydrous by a heat not exceeding 300°) in 1 fluid ounce of water.

Dose.—5 to 10 minims ($=\frac{1}{24}$th to $\frac{1}{12}$th of a grain) gradually increased if necessary to 20 ($=\frac{1}{6}$th of a grain).

2. **Ferri Arsenias**, *P.B.* *Arseniate of Iron.*

$3FeO,AsO_5$ or Fe_32AsO_4.

The arseniate of iron is partially oxydised. It is prepared by precipitating a solution of arseniate of soda by one of sulphate of iron. It has been long used by Continental physicians, having received the approval of a commission of the French Academy in 1864.

Preparation.—Dissolve 4 ounces of *arseniate of soda*, dried at 300°, and 3 ounces of *acetate of soda* in 2 pints, and 9 ounces of *sulphate of iron* in 3 pints of *boiling water;* mix the two solutions; collect the white precipitate which forms on a calico filter, and wash until the washings cease to be affected by a dilute solution of chloride of barium. Squeeze the washed precipitate between folds of strong linen in a screw press, and dry it on porous bricks in a warm air chamber whose temperature shall not exceed 100°.

Arseniate of soda, like the normal phosphate (see p. 162), liberates acid when mixed with solutions of the metallic salts, thus:

$$2Na_2HAsO_4 + 3FeSO_4 = Fe_32AsO_4 + Na_2SO_4 + H_2SO_4.$$

As the arseniate of iron is soluble in the free sulphuric acid, a loss would occur, and to avoid this, acetate of soda is employed in the above process, the nascent sulphuric acid decomposing it and liberating acetic acid, which has no solvent action on the ferrous arseniate, in its place. The arseniate of iron must be quickly dried and preserved from the air; for, like all the protosalts of iron, it is liable to peroxydation.

Characters and Tests.—A tasteless green amorphous powder, insoluble in water, but readily in hydrochloric acid. This solution gives a copious light blue precipitate with yellow prussiate of potash (indicating a little persalt of iron), and a still more abundant one of a deeper colour with the red prussiate of potash (the iron being chiefly in the form of protosalt, see p. 197). A small quantity boiled with an excess of caustic soda gives a solution (of arseniate of soda), which when filtered (from oxyde of iron which is formed, $Fe_32AsO_4 + 6NaHO = 3FeOH_2O + 2Na_3AsO_4$), and neutralised exactly by nitric acid, forms a brick-red precipitate (Ag_3AsO_4) on the addition of nitrate of silver. The solution in hydrochloric acid, when diluted, gives no precipitate with chloride of barium (absence of sulphuric acid). 20 grains dissolved in an excess of hydrochloric acid, diluted with water, continue to give a blue precipitate with the red prussiate of potash until at least 170 gr. measures of the volumetric solution of bichromate of potash have been added (indicating the proper proportion of protosalt of iron. The iron in the salt is apt to become peroxydised, especially if it is not quickly dried, and there should be at least so much of the protoxide as to require this quantity of the bichromate to peroxydise it).

Action. Uses.—Applied externally, it is a caustic; given internally, it is dissolved in the stomach, and acts like other compounds of arsenic. Mr Carmichael used it as an application to cancerous tumours and sores. It forms a slough, which separates in a few days. It may be diluted with 4 parts of phosphate of iron, 30 grains of the arseniate being used with 120 grains of the phosphate.

Cazenave and Biett have given it internally in herpetic and squamous eruptions. M. Dupare states that it does not produce the same unpleasant symptoms as the alkaline salts of arsenic.

Dose.—$\frac{1}{16}$ to $\frac{1}{2}$ of a grain in pill. For external use, 30 grains may be made into an ointment with 1 ounce of lard. Its use as a caustic is dangerous, and requires the greatest caution. Since it possesses no advantage over less dangerous compounds, it ought not to be used for this purpose.

SULPHIDES AND IODIDE OF ARSENIC.

The most important of these are the two native sulphides, *realgar* and *orpiment*, and the *diarsenic pentasulphide*, As_2S_5, which corresponds in constitution to arsenic anhydride, As_2O_5. Of these the first two only require notice in this work.

1. **Realgar**, $AsS_2 = 107$ or $As_2S_2 = 214$, was in ancient times employed in medicine, and still is in India. It is usually met with in red vitreous masses, or as a red powder, being employed as a pigment. It is very poisonous, and acts in the same way as arsenious acid.

2. **Orpiment** (*Auripigmentum*), or *Sesquisulphide of Arsenic*, $AsS_3 = 123$ or $As_2S_3 = 246$, may be produced artificially by passing sulphuretted hydrogen through solution of arsenious acid. The orpiment of the shops is a mixture of sulphide and arsenious acid, and is hence more rapidly poisonous than natural orpiment. After death, any arsenious acid contained in the body is converted into sesquisulphide by the sulphuretted hydrogen generated in the decomposition of the body.

King's Yellow is another impure sulphide, of which the finest kinds are said to be imported from the East. Dr Christison states that, according to his experiments, it contains a large proportion of sulphide of arsenic, some lime and about 16 per cent. of sulphur.

1. **Teriodide of Arsenic**, *Arsenici teriodidum*, AsI_3 or AsI_3, is an orange-red powder, without taste or smell, easily volatilised. It may be obtained by heating a mixture of 1 part of metallic arsenic with 3 parts of iodine. It is soluble in both water and alcohol, and has the action of arsenic and iodine. It has been administered with benefit in doses of $\frac{1}{8}$, gradually increased to $\frac{1}{4}$ of a grain, in some chronic cutaneous diseases, as lepra and psoriasis. It is contained in the next preparation.

2. **Liquor Arsenici et Hydrargyri hydriodatis.** *Solution of Iodides of Arsenic and Mercury. Donovan's Solution.*

This preparation was introduced into medical practice by Mr Donovan of Dublin.

Preparation.—Rub together 6 grains of *arsenic* in fine powder, 16 grains of *mercury*, 50½ grains of *iodine*, and ½ a fluid drachm of *alcohol*, until a dry mass is obtained; and having triturated 8 fluid ounces of *water* with this in successive portions, let the whole be transferred to a flask, and heated until it begins to boil. When cool add water to make it measure 8 fluid ounces and 6 drachms.

The alcohol aids the combination of the iodine with the metals. The iodine used is about sufficient to convert the arsenic into a teriodide (AsI_3), and the mercury into a periodide (HgI_2). The proportion of the three elements in 1 fluid ounce are equivalent to 1 grain of arsenious acid, 2 grains of oxyde of mercury, and 6 grains of iodine.

The colour of the solution is a greenish-yellow; it has a styptic taste; it precipitates solutions containing opium or morphia. Mercury, iodine, and arsenic may be recognised in it by their respective tests.

Soubeiran forms a solution containing 1 part each of the iodides in 100 of the solution, by dissolving 172½ grains of HgI_2 and 188½ grains of AsI_3 in 40 ounces of water. This is a little stronger than Donovan's solution.

Action. Uses.—It combines the effects of arsenic and mercury with those of iodine. It has been used successfully in syphilis, as well as in lepra and other skin diseases.

Dose.—10 to 30 minims; to be given cautiously, like the other preparations of arsenic.

SILVER: Ag = 108 or **Ag** = 108. F. *Argent.* G. *Silber.*

Silver is found native or combined with sulphur, in considerable quantities; also as a chloride, and alloyed with other metals, especially lead, gold, antimony, arsenic, copper. It is widely diffused in nature. It is separated from its ores by the process of amalgamation; or from argentiferous galena, by roasting to expel the sulphur, and submitting the lead (which contains silver) to the process of cupellation. The Arabs are thought to have been the first to employ it in medicine. In its metallic state it is inert, and being little liable to alteration, or to be affected by reagents, it is much employed for surgical instruments and chemical vessels.

Argentum purificatum, *P.B.* *Pure Metallic Silver.*

Is prepared by dissolving commercial silver in nitric acid. The liquid is diluted and filtered from undissolved gold or sulphide of silver, and then precipitated by a slight excess of chloride of sodium. The chloride of silver is thoroughly washed with water, mixed with sulphuric acid, and then reduced by the introduction of bars of zinc. The reduced silver is digested in dilute sulphuric acid to remove basic salts of zinc, well washed, redissolved in nitric acid, again precipitated as chloride, and the washed chloride reduced at a red heat by a mixture of chalk and charcoal.

Properties.—Silver is remarkable for its whiteness and brilliancy, as well as for its malleability; sp. gr. 10·53. Unalterable in the air, with the exception of a little tarnishing from the formation of a film of sulphide. It melts at a bright red heat of 1873°, and absorbs 22 times its bulk of oxygen mechanically as charcoal does. On rapid cooling this escapes and causes "spitting" of the still fluid central parts of the mass, the ejection of globules of the molten metal resulting from the rapid contraction of the solidifying outer crust. Its vapour may be oxydised in a current of oxygen, but it is unaffected by oxygen at lower temperatures; nitric acid oxydises the metal very readily. Hydrochloric acid acts but slowly upon it. Diluted hydriodic acid dissolves it, with evolution of hydrogen. Boiling sulphuric acid dissolves it, with evolution of sulphurous anhydride. It combines slowly with chlorine, bromine, and iodine. Moist chloride of sodium corrodes it slowly in the air, chloride of silver and soda being formed. It combines with phosphorus at a high temperature. But sulphur is the element for which silver has the greatest attraction, and it soon tarnishes in air containing a trace of the gaseous compounds of sulphur.

Impurities.—Commercial silver commonly contains traces of gold, copper, and lead, and these are readily detected by the following tests. The standard silver of this country contains 18 parts of copper to 222 parts of silver, or 7·5 per cent., and has sp. gr. 10·30.

Tests.—It is wholly soluble in nitric acid (gold would be left as an insoluble brown powder). If ammonia be added in excess to a solution of the metal in nitric acid, the resulting fluid exhibits neither colour (absence of copper—see p. 233) nor turbidity (lead-plumbic oxyde which is insoluble in ammonia).

Pharmaceutical Uses.—The preparation of Argenti nitras. A thin sheet of silver may be used to detect the presence of nitric acid in acetic or any vegetable acid. Being soluble in nitric acid, a solution containing this acid would, after a plate of silver had been immersed a short time in it, give a precipitate ($AgCl$) with hydrochloric acid or chloride of sodium.

OXYDES OF SILVER.—Of the three, viz., *suboxyde* (Ag_4O), *oxyde* (Ag_2O), and *peroxyde* (Ag_2O_2), the oxyde is alone thoroughly salifiable, the other two are therefore unimportant. The oxyde is fully described below.

CHARACTERS OF THE SALTS OF SILVER.—The soluble salts are colourless, have an acrid metallic taste. Their solutions are neutral to test paper, and give with the *hydrates of the fixed alkalies* a brown hydrated oxyde, and with *their carbonates* a white argentic carbonate (Ag_2CO_3), both precipitates being insoluble in excess of the precipitant; *ammonia* a brown precipitate, and *its sesquicarbonate* a white carbonate, and both precipitates are soluble in excess of the precipitant. *Sulphuretted hydrogen and ammonic hydrosulphide*, a black precipitate (Ag_2S), insoluble in excess. *Hydrochloric acid*, or *a soluble chloride*, a white curdy precipitate ($AgCl$), insoluble even in boiling nitric acid, but readily soluble in ammonia, and in sodic hyposulphite, forming a very sweet solution. *Iodide* or *bromide of potassium* give a yellowish-white precipitate (AgI or $AgBr$), but sparingly soluble in ammonia. *Hydrocyanic*, *phosphoric*, *chromic*, *oxalic*, *tartaric*, and *citric acids*, all form insoluble precipitates with salts of silver. The alkaline *arsenites* give, like the phosphates, a yellow precipitate (Ag_3AsO_3); the *arseniates*, a brick-red precipitate (Ag_3AsO_4). *Phosphorus*, *mercury*, *copper*, and *zinc* precipitate metallic silver.

ARGENTI OXYDUM, *P.B.* *Oxyde of Silver.*

$AgO = 116$ or $Ag_2O = 232$.

Contains in 100 parts, Ag 93·1 and O 6·9.

Argentic oxyde or protoxyde of silver is prepared by precipitating a solution of the nitrate with one of the fixed alkalies.

Preparation.—Dissolve ½ ounce of crystals of *nitrate of silver* in 4 ounces of *water*, and having poured the solution into a bottle containing 3½ pints of *solution of lime*, shake the mixture well, and set it aside to deposit the oxyde. Draw off the supernatant liquid, collect the deposit on a filter, wash it with 6 ounces of water, and dry it at a heat not exceeding 212°. Keep it in a stoppered bottle.

In this process the nitric acid and oxygen change places, $2AgNO_3 + CaO = Ca2NO_3 + Ag_2O$. The product is contaminated with a trace of nitrate of lime, owing to the imperfect washing prescribed. If a sufficiency of water were used, there would be a slight waste, as the hydrated oxyde is feebly soluble in water. The oxyde becomes anhydrous in the process of drying. Freshly prepared solution of potash or soda may be conveniently used instead of lime water; 120 grains of caustic potash and 320 grains of nitrate of silver yield about 180 of the oxyde. Lime water is preferred, because any carbonic acid that may have been absorbed is precipitated.

Characters and Tests.—An olive-brown powder. It combines easily with acids and forms salts, which are almost all anhydrous; slightly soluble in pure water, giving the solution an alkaline reaction; feebly soluble in ammonia, and the solution on exposure to the air deposits an explosive black micaceous powder (fulminating silver). At a low red heat the oxyde evolves oxygen, and is reduced to the metallic state. It dissolves completely in nitric acid without the evolution of any gas (carbonic acid derived from the alkali employed for precipitating the oxyde), forming a solution which has the characters of nitrate of silver. 29 grains heated to redness leave 27 grains of metallic silver (simply losing 2 grains of oxygen).

Action and Uses.—The salts of silver have no appreciable physiological action; the oxyde is dissolved in the acid secretions of the alimentary canal, and passes into the blood, and thence into the various tissues in which it is deposited probably as chloride. Under the influence of exposure this is converted into a dark insoluble subchloride, which remains fixed, in combination doubtless with the albumin, in the vascular corium, imbuing the skin with a permanent and characteristic leaden colour. This effect is produced without any appreciable evidence of the action of the silver on the bodily functions.

The oxyde is regarded as a local astringent and sedative to the mucous membrane, and as a tonic and sedative to the nervous system. Hence it is employed in gastrodynia, pyrosis, in irritable conditions with excessive secretion of the intestinal mucous membrane, in leucorrhœa and dysmenorrhœa, and in epilepsy and chorea. Numbers of epileptics have been permanently stained by its use, but it has never yet been shown that it has exercised such a good influence in this disease as to warrant its prolonged use, or that it is more beneficial than the unobjectionable salts of zinc and copper.

It is applied externally, in the form of powder or ointment, as an astringent to irritable ulcers of the skin and mucous membrane.

Dose.—½ to 2 grains in the form of pill, with liquorice powder.

ARGENTI NITRAS, *P.B.* *Nitrate of Silver.*

$AgO,NO_5 = 170$ or $AgNO_3 = 170$.

Argentic Nitrate. Lunar Caustic. Lapis Infernalis. F. *Nitrate d'Argent.* G. *Silbersaltpeter.*

Contains in 100 parts, Ag_2O 68·23 and N_2O_5 31·77.

Nitrate of silver was known to Geber, and has been long employed in medicine. Two forms are used, the crystallised and fused. It has a very strong metallic taste, and is so bitter as to have acquired the name *Fel metallorum*, also *Centaurea mineralis.*

Preparation.—Add 2½ fluid ounces of *nitric acid* diluted with 5 ounces of *water* to 3 ounces of *purified silver* in a flask, and apply a gentle heat till the metal is dissolved. Decant the clear liquor from any black powder which may be present into a porcelain dish, evaporate, and set aside to crystallise; pour off the liquor, and again evaporate and crystallise. Let the crystals drain in a glass funnel, and dry them by exposure to the air, carefully avoiding the contact of all organic substances. To obtain the nitre in rods, fuse the crystals in a capsule of platinum or thin porcelain, and pour the melted salt into proper moulds. Nitrate of silver must be preserved in bottles carefully stoppered.

The silver displaces hydrogen from one portion of the nitric acid, and the nascent hydrogen deoxydises another portion of the acid, forming water and nitric oxyde, which is converted into peroxyde on contact with the air:

$$3Ag_2 + 8HNO_3 = 6AgNO_3 + 4H_2O + 2NO.$$

Characters and Tests.—In hard, anhydrous, colourless, tabular crystals (sp. gr. 4·336), the primary form of which is the right

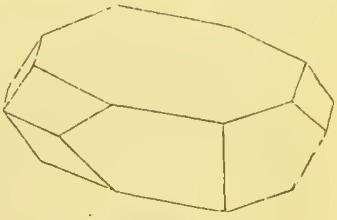

Fig. 52.

rhombic prism (fig 52), or in white cylindrical rods of crystalline structure; soluble in an equal weight of cold water, in half its weight of boiling water, and in four parts of boiling alcohol, but deposits most of it on cooling. The aqueous solution is neutral to test paper, and gives with hydrochloric acid a curdy-white precipitate ($AgCl$), which darkens on exposure to light (chlorine is set free and a subchloride is formed), and is soluble in solution of ammonia.* The salt fuses at 426°, above this it is converted, by loss of oxygen, into nitrite of silver, and at a bright red heat it is completely decomposed, leaving a residue of metallic silver. A small fragment heated on charcoal with the blowpipe, first melts and then deflagrates, leaving behind a dull white metallic coating. 10 grains dissolved in 2 fluid drachms of water, give with hydrochloric acid a precipitate ($AgCl$), which, when washed and thoroughly dried, weighs 8·44 grains (one of the processes for the estimation of silver, 100 grains of fused chloride are equivalent to 75·27 of the metal). The filtrate, when evaporated by a water bath, leaves no residue (absence of impurities, such as copper, lead, nitrate of potash).

Impurities.—Pure argentic nitrate or its aqueous solution is not affected by light; but if organic matter be present, it is readily decomposed, and blackens, from formation of oxyde in combination with the organic matter. Sticks of lunar caustic are often grey on the surface from this cause, the paper in which they are rolled probably furnishing a trace of organic matter. The fused salt is apt to contain a trace of reduced silver, and if it be not prepared from purified silver, traces of copper and lead.

Incompatibilities.—All acids, both organic and mineral, except of course nitric, all of which cause an insoluble precipitate, silver forming a greater number of insoluble salts than any other metal. The alkalies and their carbonates, lime water; the chlorides, iodides, bromides, cyanides, phosphates, arsenites, and arseniates; spring and river water; astringent infusions,—tannic acid, which reduces the nitrate to metallic silver with the formation of gallic and carbonic acids; albumin, and organic matters generally.

Action. Uses.—Nitrate of silver resembles the oxyde in its general action. Applied locally in the solid form, it is *caustic*, first whitening (from deposit of chloride of silver) moist surfaces, and after a time blackening (from formation of subchloride or oxyde) a drier surface. When rubbed to and fro three or four times upon the moistened skin, it produces vesication. It is thus used to destroy morbid growths, and applied to ulcers and poisoned bites.

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* The addition of caustic potash or soda to an ammoniacal solution of the chloride, or to the solution of ammonio-nitrate, precipitates *fulminate of silver*, a most dangerous compound, because it is liable to explode even under water.

It is used in solution to form *astringent* lotions, and collyria in ophthalmia. It excites a healthy action in inflamed mucous surfaces. Internally, in small doses, it is given as an *anticonvellent*, more especially in epilepsy. To do good it must be continued for some time, and is then apt to produce a leaden hue of the skin, which cannot be removed. It is sometimes given in pyrosis and gastrodynia, acting directly on the mucous membrane of the stomach.

Dose.—$\frac{1}{4}$ to 2 grains, in the form of pill. It is usually decomposed into chloride by the hydrochloric acid of the stomach, or the chloride of the alimentary canal. As a collyrium, from 1 to 20 grains to the ounce. As an urethral injection, it should never exceed 5 grains in the fluid ounce. When it is necessary to apply solid caustic or a strong solution (40 grains to 1 ounce of water) to a corneal ulcer, for example, care should be taken to prevent contact of the caustic with the healthy surface, and this is best effected by a solution of common salt (20 grains to 1 ounce of water). The part to which the caustic has been applied should be freely brushed over with this before the surfaces are allowed to fall in contact, in order to decompose any excess of the nitrate of silver.

Pharmaceutical Uses.—Employed as a test for chlorides, phosphates, arsenites, and arseniates, and in the form of the following solutions:—1. For estimating the quantities of hydrocyanic acid, bromine and arsenic acid, in dilute hydrocyanic acid, bromide of potassium, and arseniate of soda; 2. As a test for the presence of phosphoric and arsenious acids.

1. Volumetric Solution of Nitrate of Silver, *P.B.* 1000 grs. measures = 17 grains.

Prepared by dissolving 170 grains of the nitrate in a 10,000 grain flask, and afterwards adding more water until it measures 10,000 gr. measures exactly. The solution should be kept in an opaque-stoppered bottle. 1000 gr. measures of this solution contain $\frac{1}{10}$th of an equivalent in grains of nitrate of silver (or 17 grains).

Grammes and cubic centimetres may be employed instead of grains and grain measures; but for convenience, $\frac{1}{10}$th of the number should be taken. 100 cubic centimetres contain $\frac{1}{100}$th of an equivalent in grammes of nitrate of silver (or 1·7 grammes).

It is used in testing the following substances:—

	Grains.		Gr. measures.		Grammes.		Cub. cent.
Acid. hydrocyanic dilut.,	270	=	1000	or	27·0	=	100·0
Potassii bromidum,	10	=	840	or	1·0	=	84·0
Sodæ arsenias (dry),	10	=	1613	or	1·0	=	161·3

2. Solution of Ammonio-Nitrate of Silver, *P.B.*

Dissolve $\frac{1}{4}$ ounce of the *nitrate* in 8 fluid ounces of *water*, and add *solution of ammonia* ($\frac{1}{2}$ fluid ounce or a sufficiency) until the precipitate first formed is nearly dissolved. Clear the solution by filtration, and then add water that the solution may measure 10 fluid ounces.

Pharmaceutical Uses.—To detect the presence of arsenious and phosphoric acids. The arseniates and normal phosphates liberate nitric acid when added to nitrate of silver (see p. 162); and as both the arsenite (Ag_3AsO_3) and phosphate (Ag_3PO_4) of silver are soluble in nitric acid, the ammonio-nitrate is required to precipitate them. Both salts are of a canary-yellow colour.

Antidotes.—Give chlorides, milk, or albumen, and then evacuate the stomach.

GOLD: Au = 196·5 or **Au** 196·5.

Aurum. Sol. Rex Metallorum. F. *Or.* G. *Gold.*

The Greeks and Arabs employed this metal medicinally. The alchymists diligently investigated its properties for the purpose of finding the "*elixir vitæ;*" but the Hindoos seem to have preceded them in this course. Gold is always found native, in cubes, octohedra or tetrahedra, or in plates and masses (nuggets). It is always alloyed with silver, and occasionally contains traces of copper, antimony, osmium, iridium, and tellurium.

Properties.—Pure gold is nearly as soft as lead; it is the most malleable of metals, and is nearly as ductile as silver. Its fusing point is above that of silver. At a very intense heat it is slightly volatile, and burns with a green flame. Its sp. gr. is 19·8; its oxyde is reducible by heat. Gold is unchanged in the air; unaffected by any simple acid except selenic, but soluble in nitro-hydrochloric acid, owing to the presence of free chlorine. It combines directly with chlorine, bromine, and fluorine at ordinary temperatures, and with phosphorus when heated.

1. **Pure or Fine Gold,** *P.B.*

Gold free from metallic impurities; is prepared by solution in aqua regia, evaporating with excess of hydrochloric acid, diluting the solution with a large quantity of water to precipitate argentic chloride; precipitation of the solution of auric chloride by sulphate of iron, boiling the precipitated metal twice in fresh portions of hydrochloric acid to remove argentic chloride and traces of iron, and lastly fusing it with hydropotassic sulphate in a Hessian crucible, by which the last traces of argentic chloride are removed.

Pharmaceutical Uses.—The preparation of solution of perchloride. Gold leaf is a test for the presence of free chlorine in solution, and was employed in a former Pharmacopœia to ascertain the absence of free chlorine in hydrochloric acid.

2. **Pulvis Auri**—gold leaf rubbed up with honey or sulphate of potash and then lixiviated, forming a fine brown powder; or precipitated, as above indicated, by sulphate of iron—has been prescribed in doses from ½ to 1 grain twice or thrice a day. MM.

Chretien and Lallemand regarded it as beneficial in syphilis and scrofula.

OXYDES OF GOLD.—Of these two, the *suboxyde* (Au_2O), and the *Sesquioxyde* (Au_2O_3) or auric acid, the latter alone has been used in medicine. It is prepared by precipitating the perchloride with magnesia, and washing the precipitate in nitric acid. It falls as a yellow hydrate from a weak solution, and as a brown anhydrous powder from a strong one. It is gradually reduced by exposure to light, and is immediately resolved into metal and oxygen at 473°. It is soluble without change in strong nitric and sulphuric acids, but it is converted into auric terchloride, terbromide, and teriodide respectively, by hydrochloric, hydrobromic, and hydriodic acids. It also combines with the alkalies, forming aurates. Potassic aurate ($KAuO_2$, $3H_2O$) is crystalline and soluble.

CHARACTERS OF THE SALTS OF GOLD.—They are all decomposed when ignited in the air, a bead of gold remaining; a brown precipitate of metallic gold on the addition of solution of *sulphate of iron* in the absence of nitric acid ($6FeSO_4 + 2AuCl_3 = 2(Fe_2SO_4) + Fe_2Cl_6 + Au_2$); the formation of purple of Cassius ($Au_2Sn_3O_6,4H_2O$), on the addition, drop by drop, of a mixture of dilute solutions of stannous and stannic chloride. Metallic tin gives the same precipitate, and is a more delicate test.

Terchloride of Gold: $AuCl_3 = 303{\cdot}1$.

Contains in 100 parts, Au 64·86 and Cl 35·14.

Auric chloride, or terchloride of gold, is prepared by evaporating a solution of the metal in aqua regia, keeping the hydrochloric acid in excess, to dryness at a temperature not exceeding 248°. It forms a red deliquescent mass, and an orange coloured solution with water, which may be very much diluted without losing colour. Soluble in alcohol, and so very soluble in æther that this will separate it from its aqueous solution. It forms a crystalline compound with hydrochloric acid and many of the chlorides.

Hydrochlorate of chloride of gold has the following composition: $AuCl_3,2HCl,H_2O$; and the

Chloride of gold and sodium: $AuCl_3NaCl,2H_2O$. This is a permanent salt; it may be prepared by adding 1 part of chloride of sodium in solution to 5 parts of auric chloride, also in solution, and crystallising by evaporation. It forms long, 4-sided, deep yellow prisms, and is the most suitable salt of gold for medicinal use. Its action and remedial effects are said to resemble those of corrosive sublimate. It may be given in doses from $\frac{1}{12}$ to $\frac{1}{4}$ of a grain. It is chiefly prescribed in syphilis.

1. Solution of Chloride of Gold, *P.B.*

This is prepared by dissolving 60 grains of *fine gold*, which has been *rolled into a thin leaf*, in a mixture of 1½ fluid ounce of *nitric acid* and 6 fluid ounces of *hydrochloric acid*, first mixed with 4 fluid ounces of *water*. When the gold is dissolved, 1 fluid ounce of hydrochloric acid is added to the solution, and it is then evaporated at a heat not exceeding 212° until acid vapours cease to be evolved. The chloride of gold thus obtained is then dissolved in 5 fluid ounces of water, and the solution is kept in a stoppered bottle.

The gold unites with the free chlorine of the aqua regia (see p. 306) to form the auric chloride.

Pharmaceutical Use.—A test for atropia.

Iodide of Gold: $AuI = 323·5$.

This is the more stable of the two iodides of gold. It is prepared by precipitating the solution of perchloride of gold with one of iodide of potassium. The iodide falls with free iodine; $AuCl_3 + 3KI = AuI + 3KCl + I_2$.

The mixed precipitate is placed on a filter and washed with spirit, which removes the iodine.

The aurous iodide is a greenish-yellow powder, slightly soluble in boiling water. It has been recommended in secondary syphilis, in doses of from $\frac{1}{20}$ to $\frac{1}{15}$ of a grain, and to be applied in the form of ointment.

PLATINUM: $Pt = 98·5$ or $Pt = 197$.

Platinum is found native, alloyed with other metals. The pure metal may be obtained by precipitating the solution in aqua regia by ammonia, and heating the precipitated ammonio-platinic chloride to redness, and welding it at a high temperature. It is greyish-white; malleable and ductile; sp. gr. 21·5: fusible before the oxyhydrogen blowpipe; unchanged by air or moisture; nitrohydrochloric acid alone dissolves it, and this but slowly. Heated to redness in contact with caustic alkalies, especially hydrate of lithia and baryta, an oxyde is formed which combines with the alkali, and thus the platinum (crucible) is corroded.

Platinum foil and crucibles are made by fusing crude platinum ore by the oxyhydrogen blowpipe upon a bed of lime with a small quantity of lime. Palladium and osmium are volatilised; the copper and iron are oxydised, and form fusible compounds with the lime; the platinum remains alloyed with small portions of rhodium and iridium, which improve its qualities for chemical purposes, making it harder, less fusible, and less liable to corrosion.

Platinum Black is the metal in a minute state of subdivision. It is obtained by adding excess of carbonate of soda and some sugar to a solution of perchloride of platinum, and boiling until a black precipitate is formed. This is washed and dried.

It has the property of absorbing many times its bulk of oxygen gas and condensing it from the air, and this confers upon it remarkably active oxydising properties, converting alcohol into acetic acid (p. 349), and fusel oil into valerianic acid (p. 347), and causing the ignition of combustible gases. This property is also possessed in a minor degree by *spongy platinum*.

CHARACTERS OF THE SALTS OF PLATINUM.—These are illustrated by the perchloride (see below). They are as follows:—Complete decomposition when heated, metallic platinum remaining. *Caustic potash*, or any *salt of potash*, gives a yellow crystalline precipitate ($2KCl,PtCl_4$), soluble in large excess of caustic potash. *Ammonia and its salts* give a similar isomorphous precipitate. *Caustic soda* gives a brown precipitate of hydrated dioxyde (PtO_2) soluble in excess of alkali.

PERCHLORIDE OF PLATINUM.

$PtCl_2 = 169{\cdot}5$ or $PtCl_4 = 339$.

Contains in 100 parts, **Pt** 58·11 and **Cl** 41·89.

Bichloride or *Tetrachloride of Platinum*. *Platinic Chloride.*

This resembles the gold salt. It is deliquescent, and forms a deep orange-red solution with water, and separating from supersaturated solutions in prisms of a deep orange colour. It is very soluble in alcohol and in æther. Heated to 455° it is converted by loss of chlorine into *platinous chloride*, $PtCl_2$, and at a higher temperature metallic (*spongy*) platinum is left. It forms double salts with the other chlorides.

Potassio-platinic chloride, $2KCl,PtCl_4 = 488$, crystallises in octohedra, is sparingly soluble in water, and insoluble in alcohol and æther. It is decomposed by a red heat into potassic chloride and metallic platinum (see p. 122).

Sodio-platinic chloride, $2NaCl,PtCl_4 6H_2O$, is soluble in water, alcohol, and æther. It may be prepared by mixing a solution of 59 parts of chloride of sodium with one of 170 parts of perchloride of platinum and evaporating; it crystallises in beautiful red striated prisms. It corresponds to the chloride of sodium and gold, and is like it the most suitable means of exhibiting the metal. It is used like the gold salt in syphilis. It is less corrosive, and may be prescribed in doses ranging from ⅛ to ¼ of a grain.

Ammonio-platinic chloride, $2H_4NCl,PtCl_4$, is isomorphous with the potassium salt, and like it, is insoluble in water, alcohol, and æther. Ammonia is estimated in this form (see p. 121). It is also a means of removing platinum from its solutions, and for procuring pure spongy platinum.

1. Solution of Perchloride of Platinum, *P.B.*

This is prepared in the same manner as the solution of chloride of gold; ¼ ounce of *thin platinum foil* is digested in a flask at a gentle heat, with a mixture of 1 fluid ounce of *nitric acid*, 4 fluid ounces of *hydrochloric acid*, and 2 ounces of *water*. If necessary, more of the acid mixture is added until the metal is dissolved. The solution is then evaporated over a water bath in a porcelain dish, with 1 fluid drachm more of hydrochloric acid, until acid vapours cease to be evolved. The residue is then dissolved in 5 ounces of water, and preserved in a stoppered bottle.

The platinum is attacked, and dissolved with combination, by the free chlorine of the aqua regia (see p. 93).

Pharmaceutical Uses.—A test for potassium (see salts of potash, p. 122), forming with solutions of its salts in the presence of free hydrochloric acid the potassio-platinic chloride above described. Solutions of the salts of ammonium give an isomorphous ammonio-platinic chloride, which is readily distinguished from the potassium salt by heat (see p. 121).

PART SECOND.

ORGANIC KINGDOM:

As it was found appropriate and convenient to approach the study of the inorganic division of Materia Medica with a consideration of air and water, so will it be found equally desirable to take starch, cellulin, sugar, their associates and derivatives, as an introduction to the more complex organic division of the subject. For while these bodies form the natural link between inorganic and organic nature, like air and water, they meet us at every turn of our investigations into the constitution of vegetable life and structure, and will be found to exercise, or at least to indicate, an influence as universal as their presence.

CELLULIN or **LIGNIN.** *Woody Fibre.*

$C_{18}H_{30}O_{15}$.

This, the proper ligneous tissue, exists in a great variety of conditions, as is illustrated by a comparison of the seed of the Phytelephas or vegetable ivory, linen, paper, and cotton wool, all of which are composed of tolerably pure cellulin.

Characters and Tests.—When pure it is colourless, tasteless, soluble in a solution of well-washed freshly precipitated cupric oxyde or carbonate in dilute ammonia, from which it is precipitated unaltered by acids. It is insoluble without decomposition in other fluids. Concentrated hydrochloric acid dissolves it, and if the solution be immediately diluted it is deposited, but otherwise it cannot be recovered. Cold sulphuric acid dissolves it, forming a treacly-looking liquid which, when diluted and boiled, is first converted into dextrin, and then into glucose.

Nitric acid converts it into oxalic acid, and the caustic alkalies have the same effect (see p. 313).

When subjected to destructive distillation, cellulin is resolved into acetic acid, carbonic anhydride, carbonic oxyde, and various hydrocarbons (see Acetic acid and wood tar).

Cellulin is not coloured blue by iodine, but after it has been digested in sulphuric acid it assumes in contact with this element a brilliant blue colour. It is thus distinguished from starch.

The following varieties of cellulin are used in pharmacy and medicine:—

1. **Charta bibula.** *Filtering Paper.*

This is an almost pure form of cellulin. Water in which it is macerated should give no turbidity with any chemical reagent, and should not yield more than 0·1 per cent. of ash composed of lime salts.

Two kinds are needed in pharmaceutical and chemical operations—a coarse, for the rapid filtration of tinctures, and a fine, which shall, when swollen with water, prevent the transmission of the finer particles of precipitated argentic chloride.

The coarser kind is adapted for the preparation of

2. **Charta gummosa.** *Artificial Parchment* or *Dialysing Paper.*

To prepare this, take a sheet of filtering paper, and pass it through a mixture of 2 parts of sulphuric acid and 1 part of water at 59°. The immersion should last only a few seconds; then quickly transfer the paper to a larger bath of water, and wash it first in a stream of water, then in a weak solution of ammonia, and finally in a stream of water again, and dry spontaneously. During this short contact the sulphuric acid converts the outer surface of the cellulin into a glutinous substance which cements the fibres together. It is, according to Hoffmann, intermediate between cellulin and dextrin, but is quite insoluble in water.

By means of this paper crystalline bodies, soluble in water, may be completely separated from colloid substances, such as gum or albumin (see arabin).

3. **Linteum.** *Lint.*

This, the produce of the *Linum usitatissimum* (which see), is a very pure form of cellulin.

4. **Gossypium,** *P.B.* *Finely-carded Cotton.*

The produce of various species of Gossypium (which see). This is the purest form of cellulin.

Uses.—Besides the uses above indicated and under "Gossypium," cellulin furnishes by decomposition pyroxylin and oxalic acid.

PYROXYLIN, *P.B.* *Gun Cotton.*

$C_{18},H_{23},7NO_2,O_{15}$ (*Hadow*).

Preparation.—Mix 5 fluid ounces each of *sulphuric* and *nitric acids* in a porcelain mortar, immerse 1 ounce of *cotton* in the mixture, and stir it for three minutes with a glass rod, until it is thoroughly wetted by the acids. Transfer the cotton to a vessel containing water, stir it well with a glass rod, decant the liquor, pour more water upon the mass, agitate again, and repeat the affusion, agitation, and decantation, until the washing ceases to give a precipitate with chloride of barium. Drain the product on filtering paper, and dry in a water bath.

Edward Hadow's able investigations have rendered the composition of this remarkable body perfectly clear. A certain number of atoms of the hydrogen of the cotton (cellulin, $C_{18}H_{30}O_{15}$) are removed, and their place supplied by an equal number of atoms of peroxyde of nitrogen (NO_2), the resulting compound being about 82 per cent. heavier than the cotton employed. The more concentrated the acids employed in the process, the greater is the degree of substitution, and the heavier and more explosive the compounds. Four such compounds are known:—

1. $C_{18}H_{21},9NO_2,O_{15}$ very explosive, insoluble in alcohol + æther.
2. $C_{18}H_{22},8NO_2,O_{15}$, less explosive, soluble in 7 æther + 1 alcohol.
3. $C_{18}H_{23},7NO_2,O_{15}$, feebly explosive, very soluble in æther.
4. $C_{18}H_{24},6NO_2,O_{15}$ non-explosive, sparingly soluble in alcohol + æther.

The third of these compounds results from the action of mixed acids of the strength $H_2SO_4 + HNO_3 + 2H_2O$, which is nearly that of the mixed acids of the Pharmacopœia. The variety of pyroxylin under consideration may, therefore, be assumed to have the composition of No. 3.

Pyroxylin is insoluble in water, alcohol, and dilute acids; soluble in acetic æther, and methyl acetate. An aqueous solution of potash dissolves it with decomposition, sugar, oxalic acid, and potassic nitrate and nitrite being formed. Alcoholic solution of hydric-potassic sulphide (KHS) reconverts it into cellulin, with the formation of potassic nitrite, and the separation of sulphur (Hadow):—

$$2(C_{18}H_{23},7NO_2,O_{15}) + 14KHS = 2(C_{18}H_{30}O_{15}) + 14KNO_2 + 7S_2.$$

Tests.—Readily soluble in a mixture of æther and rectified spirit; leaves no residue when exploded by heat.

1. **Collodium,** *P.B.* *Collodion.* A solution of pyroxylin.

Preparation.—Mix 36 fluid ounces of *æther* with 12 fluid ounces of *rectified spirit*, and add 1 ounce of *pyroxylin.* Set aside for a few days, and should there be any sediment, decant the clear solution. Keep it in a well-corked bottle.

Characters.—A colourless, highly inflammable liquid with æthereal odour, drying rapidly on exposure to the air, and leaving a thin transparent film insoluble in water or rectified spirit.

Use.—Chiefly to keep the edges of incised wounds in firm contact, for example those made in the operation for hare-lip. It is admirably adapted for this purpose, for it is not only very adhesive, but as it contracts in drying it pulls the parts firmly together. Layer after layer should be applied with a camel-hair brush until the part is covered with a thick varnish-like layer. It is also useful in promoting the healing of chaps, sore nipples, and the like. For other purposes the next preparation is more suitable.

2. **Collodium flexile,** *P.B.* *Flexible Collodion.*

Preparation.—Mix together 6 fluid ounces of *collodion*, 120 grains of *Canada balsam*, and 1 fluid drachm of *castor oil*, and keep in a well-corked bottle.

Use.—As its name implies, the film which is formed on evaporation is flexible. It adheres firmly to the skin, and does not crack or split with the movements of the part. It contracts the skin to which it is applied more moderately than collodion, and it is, therefore, more suitable for application to large surfaces. It is a most valuable application in erysipelas and variola, as it not only protects the inflamed surface from sudden changes of temperature and friction, but gives it most beneficial support by virtue of its contractile power.

OXALIC ACID. *Dihydric Oxalate.*

$2HO,C_4O_6+4HO=90+36$ or $H_2C_2O_42H_2O=90+36$.

This acid derives its name from the wood sorrel (*Oxalis Acetosella*) or *oxys* (ὀξύς) of Pliny, which, like all the genus, abounds in oxalic acid in combination with potash. It is found in many other plants; the columnar stem of *Cactus pilocinereus* becomes almost as heavy as stone from the accumulation of oxalate of lime in its tissues. Rhubarb root owes its density to the same cause; and the succulent leaves, and stalks of the genus *Rumex*, notably the garden rhubarb and the *R. acetosa*, are intensely sour from the presence of the acid binoxalate of potash. It exists in such abundance in the *Cicer arietinum* that the boots are said to be blanched by walking through a field of the plant. Many lichens are stiffened by a deposit of oxalate of lime.

Oxalic acid is commonly produced in the decomposition of other vegetable acids. When either of the following substances, tartaric, citric, and malic acids, sugar, gum, starch, or even wood, is heated with excess of caustic potash, potassic oxalate is formed.

Preparation.—Oxalic acid is prepared in enormous quantities by the action of caustic alkali on sawdust (cellulin). To a solution of caustic soda and potash, sp. gr. 1·35, composed of two molecules of sodic hydrate to one of potassic hydrate, sawdust is added to form a stiff paste, the mixture is then carefully heated for five or six hours to between 392° and 482°, so as to avoid charring. Hydrogen is given off continuously, and a grey mass remains. This latter is wholly soluble in cold water, excepting the sodic oxalate. This is decomposed by boiling with slaked lime, and the oxalic acid of the oxalate of lime thus formed is set free by sulphuric acid. Thus treated sawdust yields about half its weight of crystallised oxalic acid.

Characters.—Transparent, 4-sided flattish prisms, soluble in about 9 parts of cold and 1 of boiling water, and soluble in alcohol; the solutions are intensely acid. Slowly heated to 212° the acid loses its 2 molecules of water, becoming $H_2C_2O_4$, and between 302° and

320° this dry acid sublimes in the form of colourless needles. The hydrated acid if suddenly heated is decomposed at a lower temperature into water, carbonic anhydride, and formic acid: $H_2C_2O_4,2H_2O = 2H_2O + CO_2 + HCHO_2$. Above 383° the formic acid ($HCHO_2$) splits up into water, and equal measures of carbonic oxyde and carbonic anhydride. Oxalic acid is immediately resolved into these compounds when heated with sulphuric acid: $H_2C_2O_4,2H_2O = 3H_2O + CO + CO_2$. Oxalic acid is sufficiently powerful as an acid to liberate hydrochloric acid from chloride of sodium when heated with it. It is bibasic, and forms a large number of insoluble salts with the metals (see "*Oxalates*").

Action.—A violent corrosive poison, very speedy and painful in its action. Less than half an ounce has proved fatal. The mucous membrane of the stomach is either greatly inflamed or destroyed, according as the viscus was empty or full at the time of ingestion, and to the strength of the solution employed. Oxalic acid is eliminated unchanged and usually in combination with lime, indeed the ingestion of small quantities of oxalic acid, or of the soluble oxalates, as in the form of the vegetable "rhubarb," leads to the formation of brilliant octohedra of calcic oxalate in the urine. Persons who are suffering under the oxalic diathesis, or who are prone to acid dyspepsia, should therefore scrupulously avoid articles of diet containing oxalates.

Antidotes.—Chalk, whiting, the plaster of the ceiling crushed and given with water, magnesia; but antidotes are of little use unless taken immediately after the poison.

Uses.—Oxalic acid is much used for bleaching and scouring straw and leather, and for removing ink stains. It is employed as a test in the form of a volumetric solution, being more suitable for this purpose than the mineral acids, in which it is difficult to ascertain the exact percentage of real acid.

1. Oxalic Acid Purified, *P.B.*

Is prepared by dissolving 1 pound of *commercial oxalic acid* in 30 ounces of *boiling water*, filtering, and setting the solution aside to crystallise. The liquor is then poured off, and the crystals dried by exposure to the air on filtering paper placed on porous bricks.

Tests.—It is entirely dissipated by a heat below 350°.

2. Volumetric Solution of Oxalic Acid, *P.B.*

1000 gr. measures contain 63 grains of the acid.

Preparation.—Put 630 grains of *purified oxalic acid* in crystals quite dry, but not effloresced, into the 10,000 grain flask, add about 7000 gr. measures of *water*, and allow the acid to dissolve, and then add more water until it has the exact volume of 10,000 gr. measures. 1000 gr. measures of this solution contain half an equivalent in grains (63 grains) of oxalic acid, and are, therefore, capable of neutralising one equivalent in grains of an alkali or alkaline carbonate (the acid being bibasic).

Grammes and cubic centimetres may be employed instead of grains and grain measures, but for convenience $\frac{1}{10}$th of the numbers should be taken. 100 cubic centimetres contain $\frac{1}{10}$th of an equivalent in grammes (6·3 grammes) of oxalic acid, and will neutralise $\frac{1}{10}$th of an equivalent in grammes of an alkali.

Use.—In testing the amount of base in the following solutions:—

	Grains.		Gr. meas.		Grms.		Cub. cent.
Ammoniæ carbonas, . .	59·0	=	1000	or	5·90	=	100·0
Borax, ...	191·0	=	1000	or	19·10	=	100·0
Liquor ammoniæ, . .	85·0	=	500	or	8·50	=	5·00
Liquor ammoniæ fortior, .	52·3	=	1000	or	5·23	=	100·0
Liquor calcis, ...	4380·0	=	200	or	438·00	=	20·0
Liquor calcis saccharatus, .	460·2	=	254	or	46·02	=	25·4
Liquor plumbi subacetatis, .	413·3	=	810	or	41·33	=	81·0
Liquor potassæ, ...	462·9	=	482	or	46·29	=	48·2
Liquor potassæ effervescens,	4380·0	=	150	or	438·00	=	15·0
Liquor sodæ, ...	458·0	=	470	or	458·00	=	47·0
Liquor sodæ effervescens, .	4380·0	=	178	or	438·00	=	17·8
Plumbi acetas, ...	38·0	=	200	or	3·80	=	20·0
Potassa caustica, ...	56·0	=	900	or	5·60	=	90·0
Potassæ bicarbonas, . .	50	=	500	or	5	=	50
Potassæ carbonas, . .	83	=	980	or	8·30	=	98
Potassæ citras, ...	102	=	1000	or	10·20	=	100
Potassæ tartras, ...	113	=	1000	or	11·30	=	100
Potassæ tartras acida, . .	188	=	1000	or	18·80	=	100
Soda caustica, ...	40	=	900	or	4·00	=	90
Soda tartarata, ...	141	=	1000	or	14·1	=	100
Sodæ bicarbonas, . .	84	=	1000	or	8·40	=	100
Sodæ carbonas, ...	143	=	960	or	14·30	=	96

OXALATES.

Oxalate of Ammonia (see p. 119) is employed as a test to indicate the presence of lime. The oxalates are for the most part insoluble in water and acetic acid, but they are all soluble in nitric acid. Oxalates of lime, magnesia, baryta, strontia, zinc, manganese, cadmium, lead, and silver are white; *oxalate of silver* is characteristic, for when the precipitate is dried and heated over the flame of a spirit lamp it is decomposed into silver and carbonic anhydride, with a slight explosion, $Ag_2C_2O_4 = Ag_2 + 2CO_2$. Ferrous oxalate is yellow, cupric oxalate pale blue. These oxalates are either not at all or only very feebly soluble in water. On account of its complete insolubility *oxalate of lime* is employed as the means of estimating lime. It is deposited (usually as exceedingly minute regular octohedra, only visible as such when examined by a $\frac{1}{4}$ or $\frac{1}{8}$ inch object glass) whenever a neutral oxalate, such as the oxalate of ammonia, is added to a neutral or alkaline solution of a salt of lime. When dried at 212° it loses a molecule of water, and has the composition, CaC_2O_4,H_2O. At a full red heat 100 parts leave 34·15 of CaO, corresponding to 43·9 of C_2O_4, oxalic anhydride. The oxalates of the metals of the alkalies and earths are decomposed at a dull red heat into carbonates without charring, carbonic oxyde burning on the surface with a pale blue flame.

OXALATES OF POTASH.

Oxalic acid forms both normal and acid salts with the alkali metals, and these are likely to come under the notice of the medical man, as they occur in the juices of plants, or in the form of salt of sorrel or "salt of lemons." They are as follows:—

1. **Normal or Dipotassic Oxalate:** $K_2C_2O_4,H_2O$.

Obtained by neutralising oxalic acid with carbonate or caustic potash, and concentrating the solution. It crystallises in prisms which are efflorescent, and very soluble.

2. **Hydropotassic Oxalate or Binoxalate of Potash:** KHC_2O_4,H_2O.
Sal Acetosellæ. Sel d'oseille. Salt of Wood Sorrel.

This is the form in which oxalic acid exists in the acid species of Oxalis, Rumex, Rheum, Geranium, &c. In Germany and Switzerland it is still prepared from the expressed juices of the wood sorrel (*Oxalis Acetosella*). 500 parts of the plant yield 4 parts of the crystallised salt. It may be prepared in the same way as the former, adding a double quantity of oxalic acid. It crystallises in large rhombic prisms, permanent in the air, of acid taste, and sparingly soluble in water (requiring about 40 parts).

3. **Quadroxalate of Potash:** $KHC_2O_4,H_2C_2O_4,2H_2O$.

Erroneously called "*Salt of Lemons*," and may be prepared in the same way as the normal salt by adding three times as much oxalic acid. It crystallises in large rhombic prisms, and is the least soluble of all the oxalates of potash.

Action and Uses.—Both salt of sorrel and "salt of lemons" are commonly used for removing iron mould and ink stains; and as their poisonous properties are well known, they have often been taken with suicidal intent. They are violent corrosive poisons. Dr Taylor quotes a case in which ½ an ounce of the salt of sorrel, taken by mistake for cream of tartar, killed a woman within ten minutes They are identical with oxalic acid in their action, and the antidotes are the same.

STARCH: x $(C_6H_{10}O_5)$.

Starch is the farina or flour of seeds and soft cellular roots and stems. Thus, if wheat flour made into a paste with water, or thin slices of potatoes be washed on a piece of muslin, a milky fluid will pass through, which on standing becomes clear from the deposit of the minute granules of starch which previously gave it the milky appearance.

Characters.—When this deposit is examined by the microscope, it is found to be composed of separate granules, usually of characteristic appearance and size for the same plant, but varying much in both according to the source from which it is derived. *Potato starch* (P, fig. 53) may be taken as the typical form. It is composed of flattened ovate granules, about $\frac{1}{500}$ in. broad and $\frac{1}{300}$ in. long, and marked with excessively delicate lines concentric with a spot or hilum which is usually found at one end of the granule. *Tous les Mois* (fig. 54), the starch derived from the tubers of *Canna coccinea* and *C. edulis*, is remarkable for great size (about the $\frac{1}{200}$ inch) and beauty of the granules, which give a broken-glistening appearance to this variety. *Wheat starch* (W, fig. 53), and the starch of the cereal grains generally, are, on the contrary, destitute of concentric markings, and these varieties, when magnified, present the soft glistening appearance and dark borders of minute spherules or masses of oil. The granules are tolerably uniform in size, if we except those of *rice* (R, fig. 53), which are smaller than those of any other starch ($\frac{1}{3000}$ inch). Those of wheat, barley, and oats average about the $\frac{1}{1000}$ of an inch in diameter; those of *rye* are a little larger ($\frac{1}{800}$ inch), and they usually present two to five dark cracks, extending from the hilum in various directions. Those of *maize* are a little smaller than wheat starch; the hilum is cracked and the granules are irregular, from mutual pressure, like those of rice. *Arrowroot* (West Indian, fig. 55), from the tubers of Maranta, and East Indian (A, fig. 53), from those of Curcuma, are about the same size as rye grains, but the granules, like those of root starch generally, are more elongated, and the striæ are well marked.

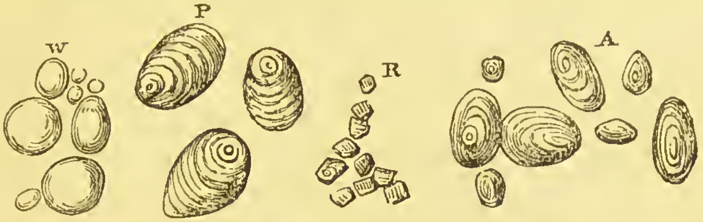

Fig. 53.

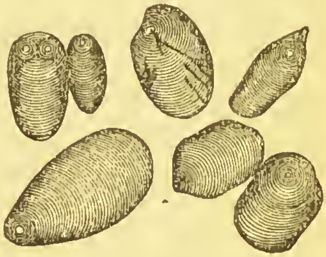

Fig. 54.
Tous les Mois.

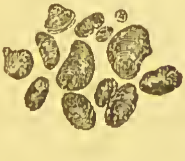

Fig. 55.
West Indian Arrowroot.

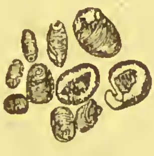

Fig. 56.—Sago.

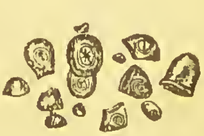

Fig. 57.—Tapioca.

Sago starch (fig. 56) and *tapioca* starch (fig. 57) closely resemble each other; the granules are spherical or mullar-shaped, about

$\frac{1}{1000}$ inch in diameter, and present well-marked rings and a minute stellate hilum.

Starch is insoluble in cold water, and owing to its sp. gr. (1·5), it is rapidly deposited when mixed with it. It may be preserved unchanged under cold water for an indefinite time; but if the mixture be heated to about 140°, the starch absorbs water, the grains swell to a great size, and become transparent and mucilaginous, and the mixture assumes the characters of a clear mucilage, thick and viscous in proportion to the quantity of starch present. If it be now mixed with a large quantity of water, the swollen granules are deposited, leaving only a portion of the amylaceous matter in solution, which is precipitated by alcohol, tannic acid, and ammoniacal plumbic acetate, forming with the latter the definite compound $C_{12}H_{18}O_9,2PbO$. If starch be boiled under pressure at 302°, with about 10 parts of water, a portion dissolves, forming a thin solution which filters readily when hot, but on cooling deposits minute spherical granules, which after drying are sparingly soluble in cold water and readily in hot.

When dried between 212° and 250°, starch loses 18 per cent. of water and becomes anhydrous. Maintained at about 401° for one or two hours, it is converted into *dextrin*, $C_6H_{10}O_5$, becoming completely soluble in water, and forming a viscid, adhesive solution, like that of gum, for which it is employed under the name of *British gum*, or *leiogomme*, in the arts. Ordinary hydrous starch undergoes this conversion by suddenly exposing it to a heat of 320°. Under the influence of animal *ptyalin* and vegetable *diastase*, apparently identical albuminous ferments, the former existing as a constant constituent of the saliva, and the latter always formed during the germination of seeds, starch is converted in sugar.

Action and Uses.—Since sugar is readily converted, in the process of fermentation, into alcohol, starch is indirectly the source of the various kinds of spirit. As an article of diet it is demulcent and nutritious. Starch in the form of dry powder is a valuable absorbent and soothing application, and as such is much employed to prevent intertrigo in infants, and to relieve this condition in adults. Mixed with equal parts of calamine or oxyde of zinc, it gives great relief in eczema. "Violet" or "hair powder" is starch scented with powdered orris root.

Amylum, *P.B.* *Wheat Starch.*

The starch procured from the seeds of *Triticum vulgare* (which see).

Characters and Tests.—In white columnar masses. When rubbed with a little cold water, it is neither acid nor alkaline to test paper; and the filtered liquid does not become blue on the addition of solution of iodine until it is mixed with boiling water and cooled.

Pharmaceutical Uses.—A constituent of Pulvis tragacanthæ compositus, and of the following two preparations:—

1. **Mucilago Amyli,** *P.B.* *Mucilage of Starch.*

Preparation.—Triturate 120 grains of *wheat starch* with 10 ounces of *water* gradually added; then boil for a few minutes, constantly stirring.

Action and Uses.—Demulcent; chiefly employed in enemata. It is also useful to the surgeon for the purpose of stiffening bandages around fractured limbs.

Pharmaceutical Uses.—In the preparation of Enema aloes, E. magnesiæ sulphatis, E. opii, and E. terebinthinæ.

2. **Glycerinum Amyli,** *P.B.* *Glycerin of Starch.*

Preparation.—Rub together 1 ounce of *starch* and 8 fluid ounces of *glycerin* until they are intimately mixed; then transfer the mixture to a porcelain dish, and apply a heat gradually raised to 240°, stirring it constantly until the starch grains are completely broken and a transparent jelly is formed.

Use.—A substitute for simple ointment when grease is objectionable; to which, however, it is far inferior in soothing properties, undiluted glycerin being rather irritant and healing to tender surfaces. If used at all, this preparation should be diluted with two parts of water.

SUGAR.

Of the several varieties of sugar, the three most important are—1. *Cane Sugar;* 2. *Milk Sugar;* and 3. *Grape* or *Starch Sugar.* These have the following properties in common:—a sweet taste, solubility in water; exercise right-handed rotation on a ray of polarised light; reduce an alkaline solution of potassic cupric tartrate, and the salts of mercury, silver, and gold when boiled with them; susceptible of alcoholic fermentation (milk sugar not directly so). Heated above 420°, decomposition into carbon, a little oily hydrocarbon, acetic acid, acetone, aldehyd, light carburetted hydrogen, and carbonic oxyde.

SACCHARUM PURIFICATUM, *P.B.* *Refined Sugar.*

$C_{24}H_{22}O_{22}=342$, or $C_{12}H_{22}O_{11}=342$.

Pure cane sugar prepared from the juice of the stem of *Saccharum officinarum* (which see), from plants cultivated in the West Indies and other tropical countries.

Characters.—Compact crystalline conical loaves, known as "lump sugar." By spontaneous evaporation of an aqueous solution, it crystallises in bold, four-sided oblique rhombic prisms, with dihedral or hemihedral summits ("sugar candy"); sp. gr. 1·6; soluble in half its weight of cold water, forming a thick, viscid syrup, of sp. gr. 1·33; in 80 parts of alcohol; in about 65 of rectified spirit; insoluble in æther. The aqueous solution produces a right-handed rotation on a ray of polarised light. By prolonged boiling it assimilates another molecule of water, and forms uncrystallisable sugar (fruit sugar, inverted sugar, or lævulose, $C_6H_{12}O_6$). If the boiling be still further continued, another molecule of water is absorbed, and the fruit sugar is converted into grape sugar, $C_6H_{12}O_6,H_2O$, minute quantities of brown, feebly soluble and uncrystallisable *ulmin* and formic acid being simultaneously formed; the presence of chlorides and weak acids, either organic or inorganic, facilitate these changes.

Sugar forms definite compounds with bases, some of which are soluble in excess of sugar, and others are soluble in alkaline solutions. Thus, oxyde of lead, lime, and baryta dissolve to a considerable extent in syrup. Lead unites to form two compounds, viz., $C_{12}H_{18}Pb_2O_{11}$ and $C_{12}H_{16}Pb_3O_{11}$. Lime dissolves to a much larger extent (see p. 173), forming $C_{12}H_{22}O_{11}CaO$; very soluble in cold water, but when boiled coagulates like white of egg; and the coagulum, when separated, is found to be $C_{12}H_{22}O_{11},3CaO$. The combination of sugar with the oxydes of iron and copper is not precipitated by alkalies. Sugar forms deliquescent double salts with calcic and sodic chloride. The latter, according to Péligot, has the following composition, $2NaCl,C_{12}H_{20}O_{10},C_{12}H_{22}O_{11}$ (see the analogous salts of gum, under "Acacia"). Sulphuric acid poured on moistened sugar or thick syrup converts it, with the extrication of much heat, carbonic and formic acids, into a bulky mass of carbon containing ulmic acid. Nitric acid of sp. gr. 1·25 converts it into saccharic acid, and the strong acid into oxalic acid with the extrication of carbonic anhydride. Sugar fuses at 320°, and on cooling assumes the viscous condition in which it is known as "*barley sugar.*" It is deliquescent, freely soluble in alcohol, and exerts little or no rotatory power on a ray of polarised light. After a time this variety loses its transparency, assumes a fine crystalline structure, and with the evolution of heat, thus returns to the normal crystalline form (see the parallel case of sulphur, p. 50). At 401° to 420° sugar parts with two molecules of water, and forms a brown deliquescent mass, with the pleasant odour of burnt sugar called *Caramel.* It is used by cooks, confectioners, and distillers as a colouring agent.

Action and Uses.—Sugar being a crystalloid is readily absorbed into the blood, and is partly resolved into water and carbonic anhydride, in which form it is extricated by the lungs; and is partly applied to the nutrition of the fatty tissues. Too free a use of sugar leads to adiposity, and this becomes very great if, from want of sufficient exercise, the respiratory function be sluggish. In disordered states of the blood, lactic and oxalic acids appear to be formed in the decomposition of sugar, which may thus originate the rheumatic and oxalic diathesis. As fuel to the respiratory process, sugar is a suitable, and, in the absence of fatty food, a necessary article of diet.

Sugar and syrup are antiseptic, and they are largely used for preserving meat and fruit. Pharmaceutically it is employed to prevent the peroxydation of iron and to increase the solubility of lime in water.

Pharmaceutical Uses.—In the preparation of Confectio rosæ caninæ, C. rosæ Gallicæ, C. sennæ, Ferri carbonas saccharata, Liquor calcis saccharatus, Mistura ferri composita, M. guaiaci, Pilula ferri iodidi, Pulvis cretæ aromaticus, P. amygdalæ compositus, P. tragacanthæ compositus, Suppositoria morphiæ. The syrups and lozenges.

1. **Syrupus,** *P.B.* *Syrup.*

Preparation.—Dissolve 5 pounds of *refined sugar* in 2 pints of *water* with the aid of heat, and add, after cooling, sufficient *water* to make the weight of the product 7½ pounds. The sp. gr. should be 1·33.

Pharmaceutical Uses.—The preparation of Mistura cretæ, M. kreasoti, Pilula cambogiæ composita, Syrupus aurantii, S. zingiberis.

2. **Theriaca,** *P.B.* *Treacle.*

The uncrystallised residue of the refining of sugar, or "*Sacchari fex.*"

Cane juice contains a little albuminous matter, which, acting as a ferment, leads to the development of a small proportion of vegetable acid in the process of boiling, and this, in turn, leads to the formation of uncrystallisable sugar (see p. 319). The same effect results from the long-continued boiling and high temperature to which the syrup is exposed. It is properly defined as an "uncrystallised residue;" for a portion at least, according to Péligot ¼ of its weight, of the syrup, is crystallisable by suitable means.

Characters.—A thick brown fermentable syrup, very sweet, not crystallising by rest or evaporation; sp. gr. about 1·4. It is nearly free from empyreumatic odour and flavour.

Pharmaceutical Uses.—The formation of pills, for which it is well adapted, because it does not dry on exposure. It is used in the following:—Pilula assafœtidæ composita, P. conii comp., P. ipecacuanhæ et scillæ, P. rhei composita, P. scillæ composita.

SACCHARUM LACTIS, *P.B.* *Milk Sugar.* *Lactin* or *Lactose.*

$C_{24}H_{24}O_{24}$, or $C_{12}H_{24}O_{12}$.

A crystallised sugar, obtained from the whey of milk by evaporation.

Characters.—Usually in cylindrical masses two inches in diameter, with a cord or stick in the axis, or in fragments of cakes; greyish-white, crystalline, translucent, hard, odourless, faintly sweet, gritty and not readily soluble in the mouth. The crystals are right four-sided prisms, terminated by four-sided pyramids; they are soluble in 6 parts of cold water, insoluble in alcohol and æther. Boiled with dilute acids, it is very slowly converted into *galactose*, $C_6H_{12}O_6$, a very soluble, crystallisable, and fermentable sugar. If allowed to ferment spontaneously in contact with chalk, lactic acid and alcohol are formed. It forms soluble compounds with oxyde of lead, the alkaline earths, and the alkalies. Its reducing action on the metallic salts has in the case of silver been taken advantage of for the purpose of silvering mirrors. Nitric acid decomposes it with the formation of *mucic acid* ($H_2C_6H_8O_8$) chiefly, and small quantities of saccharic, tartaric, racemic, and oxalic acids. Mucic acid is readily deposited as colourless tabular crystals by boiling together 1 part of gum or of milk sugar with 4 parts of nitric acid (sp. gr. 1·35) and 1 part of water.

Action and Uses.—Those of cane sugar; but on account of its insusceptibility of direct fermentation, it is employed as a substitute for ordinary sugar in the dyspepsia of infancy.

GRAPE or STARCH SUGAR. *Glucose. Dextrose.*

$C_{12}H_{12}O_{12}2HO$ or $C_6H_{12}O_6,H_2O = 180 + 18$.

This variety of sugar exists in grapes, and ripe and dried fruits generally; but it may be prepared artificially by the action of dilute acid on starch at 212°.

Preparation.—A mixture of *starch* and *water* is allowed to flow gradually into *boiling water* containing 1 per cent of *sulphuric acid.* The starch is by this means altered before it forms a mucilage, and in the course of half an hour it is completely converted into sugar. 2 parts of *acidulated water* will thus convert about 1 part of starch. The liquid is neutralised with chalk, the clear fluid decanted, evaporated, and crystallised. The crystals are minute, hard cubes, which by their aggregation form very tough, compact masses, or warty concretions. This sugar is soluble in its own weight of water. Dilute alcohol (83 per cent.) will dissolve about 21 parts at the boiling point. Sulphuric acid does not decompose it, but forms with it a compound acid, the *sulpho-saccharic.* Another distinctive feature is the formation of a readily crystallisable compound with sodium chloride ($NaCl,H_2O,2C_6H_{12}O_6$). The alkalies convert it into *glucic acid* ($H_3C_{12}H_{15}O_9$). This sugar is formed in the process of the digestion of starch, and also similarly by the action of the diatase formed in the germination of seeds, and which is the active agent in converting insoluble starch into soluble sugar in the process of brewing. Under the influence of fermentation the latter is converted into alcohol.

ALCOHOL. *Spirit of Wine.*

$C_4H_6O_2 = 46$ or $C_2H_6O = 46$.

This is the intoxicating constituent of all fermented liquors.

Preparation.—Alcohol is obtained by the distillation of any saccharine fluid which has been subjected to fermentation. Sweet worts are formed for this purpose by the action of diastase on the starch of the cereals or the potato; or the sugar of *Saccharum officinarum,* or the grape, is directly acted on by the ferment (*Torula* *cervisiæ;* see p. 364). Under the influence of this minute fungus, between 60° and 80°, the sugar is converted into alcohol and carbonic acid, thus:

$$\overset{\text{Fruit sugar.}}{C_6H_{12}O_6} = \overset{\text{Carbonic acid.}}{2CO_2} + \overset{\text{Alcohol.}}{2C_2H_6O}.$$

1 molecule of sugar breaking up into 2 of carbonic acid and 2 of alcohol. The formation of so much carbonic acid causes a brisk effervescence of the fluid so long as any sugar remains decomposed. The yeast fungus simply grows by the process at the expense of a nitrogenised constituent of the wort, and accumulates as the process advances. Dilute alcohol is obtained by distilling the clear fluid. By repeated distillations, or by a single operation in Coffey's still, it may be concentrated until it contains only 10 per cent. of water. The liquid is now distilled from charcoal, in order to deprive it of essential oils derived from the plants which furnish the sugar, and the remaining water is subsequently removed by one or two rectifications from quicklime, the alcohol being allowed contact with about half its weight of the lime for three or four days, during which time it is more or less completely slaked by the water of the alcohol; or the slight modification given below may be adopted.

1. Absolute or Anhydrous Alcohol, *P.B.*

Put 1½ ounce of *carbonate of potash* into a stoppered bottle with a pint of *rectified spirit,* and allow them to remain in contact for two days, frequently shaking the bottle. Separate the spirit from the denser aqueous solution of carbonate of potash, and pour it into a retort upon quicklime freshly prepared by heating 10 ounces of slaked lime to a red heat for half an hour in a covered crucible. A condenser being attached, allow contact for twenty-four hours, then applying a gentle heat, let 1½ fluid ounce distil. Reject this, and continue the distillation into a fresh receiver until nothing more passes at a temperature of 200°. The first portions may contain volatile oil, and are therefore rejected.

Characters.—It is a colourless, volatile, highly inflammable liquid, of sp. gr. 0·7938 at 60°; boils at 173°, and at −166° becomes viscid, but not actually frozen. It has a fruity penetrating odour and a burning taste. Exposed to the air it attracts moisture, and like sulphuric acid when mixed with water, it contracts and emits heat and minute bubbles of air which, as they rise, give the mixture a dusty appearance. Owing to its hygroscopic power it removes water from soft organic tissues, shrinking and hardening them, and preventing their decomposition. It burns without smoke and with but little light, 1 molecule (= 4 vols. of vapour) requiring 12 atoms of oxygen for its combustion. By gradual oxydation it yields aldehyd (p. 337) and acetic acid (p. 349). With nitric acid it furnishes nitrous æther, oxalic acid, glyoxal, and glycolic acid; with sulphuric acid, æther, &c. (p. 330); with chlorine, chloral, &c. (see p. 343). As a solvent alcohol stands next to water.

The following are miscible in all proportions, or very freely soluble:—Chloroform, æther, essential oils, benzol, kreasote, resins, concrete volatile oils (as camphor) and castor oil.

The following are soluble to a greater or less extent:—Sulphur, phosphorus, bromine, and iodine. Potash, soda and ammonia (freely magnesia (slightly). Arsenious acid (1 part in 250), benzoic, boracic, citric, oxalic and tartaric *acids* (moderately). *Chlorides* of ammonium (1 part in 5), barium (1 part in 400), calcium (freely), and iron both proto- and persalt; perchlorides of gold and platinum; sodio-platinic chloride. *Iodides* of potassium, iron, and cadmium (freely); of lead and arsenic, and red iodide of mercury (freely in hot). *Hypophosphites* of the metals of the alkalies. *Cyanide* of potassium. *Sesquicarbonate* of ammonia (sparingly). *Nitrates* of silver, ammonia (anhydrous), and strontia (sparingly). *Benzoates* of ammonia and iron—the ferric salt (freely). *Acetates* of potash, soda, and lead. *Tartrates* of potash (1 part in 240 boiling), of potash and iron (sparingly). *Valerianates* of soda and zinc.

The following are insoluble:—Cellulin, starch, gum, sugar, gelatin, and albumin. Baryta, lime. Carbonates of potash, soda, lime, magnesia, and lithia. Chloride of sodium. Potassio-platinic chloride. Calomel. Sulphates of soda, magnesia, iron, zinc, and copper. Hyposulphite of soda. Ferricyanide of potassium. Borax. Nitrate of lead. Acetate of copper (verdigris). Citrates of potash and magnesia. Borotartrate of potash. Acid tartrate of potash. Tartar emetic.

It must be remembered that the presence of a minute proportion of water will render some of the foregoing—*e.g.*, sodic chloride—soluble.

Some varieties of sugar are soluble. Soaps, fats, and fixed oils are but slightly soluble.

Tests of Purity.—Sp. gr. 0·7938, freedom from empyreumatic odour, entirely volatile, not rendered turbid by water (absence of essential oil or resin), and does not cause anhydrous sulphate of copper to assume a blue colour when left in contact with it (freedom from water).

Action.—In its early effects alcohol is a diffusible stimulant, exciting the mental functions, increasing the force and activity of the heart, and promoting the secretions of the skin and kidneys; after an interval of two or three hours the stimulant effects subside, and leave the individual rather tired, with a slightly diminished pulse and temperature, and an inclination to sleep. If, however, the dose have been large the primary excitement grows more intense, the eyes brighten, and becoming sluggish in their movements, assume a more or less stupid and fixed expression. This is due, as in the case of hemlock, to a depression of the accommodating power, and produces a giddy feeling. By a similar implication of the voluntary muscles, the gait is unsteady, reeling, or tottering. The individual is usually hot and flushed, but sometimes pale, and inclined to be quarrelsome or hilarious. The excitement increases to delirium, the depression of motor power to paralysis, and the patient either slips from his chair, or, if he attempts to walk, falls heavily in a heap within his centre of gravity. If disturbed, he talks thickly and incoherently or mutters unintelligibly. Heavily oppressed with sleep, he soon lapses into the narcotic stage, snoring stertorously, and completely (except, perhaps, in the condition of the pupil) resembling the condition of a person narcotised by opium. In this condition he lies with the muscles flaccid for several hours, and is then awakened by the desire to relieve a painfully distended bladder, or, if he have taken a meal during his debauch, by the nausea which precedes the rejection of the undigested food. Thus aroused, he is prostrate in mind and body, and suffers headache, nausea, and thirst for several hours more. If the dose have been a poisonous one, the narcotism becomes complete, and it is no longer possible to arouse the patient; the face grows pale, the features sunken, the respiration becomes slower, the pulse feebler, the temperature falls, the sphincters and pupils relax, and so the patient dies from paralysis of the respiratory function.

Uses.—As a *diffusible stimulant* whenever the action of the heart lacks force, but especially in syncope and in the prostration which follows or accompanies pyrexia. In failure of the heart's action from loss of blood or depressent poisons, or in collapse from shock, alcohol is a most valuable remedy, and in these cases it may be given more fully than in any others. In sea sickness it gives great relief, by sustaining the activity of the cerebral circulation. As an *anodyne* and *antispasmodic* in paroxysmal pain from violent or disordered peristaltic action; as a *local stimulant* to the stomach in atony and gastralgia.

Of late years alcohol has been greatly abused *in the treatment of acute disease*, upon the theory that it supplies the respiratory process with an easily oxydisable food, and so prevents the waste of the tissues. If it were as innocent a food as milk, which is the appropriate article of diet in acute disease, alcohol would no doubt be, for the mere purposes of combustion, a more suitable article of diet than sugar; but before we can get the respiratory effects of alcohol the nervous system must be subjected to its stimulant action, and I am satisfied that the results of its prolonged stimulation, in the prostration of typhus for example, and in doses of 1 fluid ounce every hour, for twenty-four or forty-eight hours or more, are identical with those observed in health, namely, depression of nerve force, diminution of the oxydising processes, and consequently of the temperature to an abnormal and injurious extent, and an increase of the cerebral embarrassment. It is, I believe, an erroneous assumption that an exhausted and embarrassed condition of the nervous system requires for its relief stronger stimulation than can be borne in health. We know that strong electrical currents exhaust and destroy the little excitability that lingers in the muscles of a paralysed limb, and that gentle currents increase it, and this fact might be remembered with advantage in reference to the use of alcohol, when the nervous system of the patient is already exhausted by disease. Another consideration should guide us in using or withholding alcohol, and this is the habits of the patient; and we must remember that no stimulant can supply the place of alcohol to one who is accustomed to its free use. (For further remarks on the action of spirits, wines, &c., see p. 329)..

Employed *externally*, alcohol is a mild stimulant, giving tone and hardness to the parts to which it is applied. As it facilitates the evaporation of water, it is useful as a refrigerant lotion when mixed with 8 or 10 parts of water, and applied by means of a single fold of linen.

1. **Spiritus Rectificatus,** *P.B.* *Rectified Spirit.* Sp. gr. 0·838.

This is alcohol containing 16 per cent. by weight, or 11 per cent. by volume of water, obtained by the distillation of fermented saccharine fluids.

Characters and Tests.—It agrees with the characters of pure alcohol given above, excepting in two particulars,—first, its greater specific gravity, due to the water; and, secondly, the presence of traces of fusel oil (amylic alcohol) and sometimes of aldehyd. The odour and taste, however, are purely alcoholic, and the Pharmacopœia prescribes the following test to show that the spirit does not contain an excessive quantity of the impurities just mentioned:—Mix together 4 fluid ounces of the spirit and 30 gr. measures of the volumetric solution of nitrate of silver, and expose to bright light for twenty-four hours, decant from the black powder formed, and add more solution of nitrate:—no further deposit is formed after exposure to light. Pure alcohol does not reduce nitrate of silver, whereas both fusel oil and aldehyd have this power; and an excess of these impurities is indicated by the formation of a fresh precipitate on the addition of more nitrate of silver.

Uses.—1. *Medicinal* (see above). 2. *Pharmaceutical.* All the "Spirits" and the following "Tinctures" are made with rectified spirit:—

T. Aconiti.
  Arnicæ.
  Assafœtidæ.
  Aurantii recentis.
  Benzoini composita.
  Cannabis Indicæ.
  Capsici.
  Castorei.
T. Cubebæ.
  Ferri perchloridi.
  „ acetatis.
  Iodi.
  Kino.
  Lavandulæ composita.
  Laricis.
T. Myrrhæ.
  Nucis vomicæ.
  Opii ammoniata.
  Pyrethri.
  Tolutana.
  Veratri viridis.
  Zingiberis.
  „ fortior.

2. **Spiritus Tenuior,** *P.B.* *Proof Spirit.* Sp. gr. 0·920.

This is alcohol containing 49 per cent. by weight, or 42 per cent. by volume of water. It is prepared by mixing together 5 pints of rectified spirit and 3 pints of water.

It is used in the preparation of the following tinctures:—

T. Aloes.
Aurantii.
Belladonnæ.
Buchu.
Calumbæ.
Camphoræ composita.
Cantharidis.
Cardamomi composita.
Cascarillæ.
Catechu.
Chiratæ.
Cinchonæ composita.
T. Cinchonæ flavæ.
Cinnamomi.
Cocci.
Colchici seminis.
Conii.
Croci.
Digitalis.
Ergotæ.
Gallæ.
Gentianæ composita.
Hyoscyami.
Jalapæ.
Krameriæ.
Limonis.
T. Lobeliæ.
Lupuli.
Opii.
Quassiæ.
Quiniæ composita.
„ ammoniata.
Rhei.
Sabinæ.
Scillæ.
Senegæ.
Sennæ.
Serpentariæ.
Stramonii.
Sumbul.
Valerianæ.

3. **Spiritus Vini Gallici**, *P.B.* *Brandy*, or *Spirit of French Wine.*

Distilled from wine, this spirit is free from grain oil. In addition to the aromatic principles derived from the grape, it is commonly flavoured with Vanilla. It has a light sherry colour, derived from the cask in which it has been kept. Brown brandies derive their colour from caramel (burnt sugar). According to Brande, 100 measures of brandy contain 55·39 alcohol of sp. gr. at 0·825 at 60°.

4. **Mistura Vini Gallici**, *P.B.* *Mixture of Spirit of French Wine.*

Beat up the yolk of two eggs with half an ounce of white sugar, and add 4 fluid ounces each of cinnamon water and brandy.

Dose.—1 to 2 fluid ounces.

5. **Vinum Xericum**, *P.B.* *Sherry.*

A Spanish wine, pale yellowish brown, containing about 17 or 18 per cent. of alcohol.

Uses.—1. *Medicinal* (see under 7). 2. *Pharmaceutical.*—The preparation of Vinum aloes, V. antimoniale, V. colchici, V. ferri, V. ipecacuanhæ, V. opii, and V. rhei.

6. **Vinum Aurantii**, *P.B.* *Orange Wine.*

A British wine made by the fermentation of a saccharine solution to which the fresh peel of the bitter orange has been added. It has a golden sherry colour, an orange taste and aroma, is but slightly acid to test paper, and contains about 12 per cent of alcohol.

It is an agreeable vehicle for taking cod-liver oil, and is used in the preparation of Vinum ferri citratis and Vinum quiniæ.

7. **Other Spirits, Wines, and Fermented Liquors.**

Whisky (Spiritus frumenti) is a grain spirit; it obtains its smoky flavour from the peat or turf fires used in drying the malt. *Gin* (Spiritus frumenti cum junipero) is also a grain spirit, the flavour being derived from juniper berries used in the distillation. *Rum*

Spiritus sacchari), a West Indian product, is obtained by the fermentation and distillation of molasses or treacle. The following numbers represent the quantity of alcohol (sp. gr. 0·825 at 60°) by measure, in 100 measures of the spirit:—

Rum, . .	53·68	Scotch Whisky,	54·32
Gin, . .	51·60	Irish Whisky,	53·20

Arrack (Spiritus ozyræ) is obtained from rice, or from cocoa nut toddy, when it is sometimes called "palm wine."

Koumiss is a spirituous liquor peculiar to the Tartar tribes. It is prepared by the fermentation of mare's milk. It contains about 3·5 per cent. of *alcohol;* 2 each of *albuminates, butter,* and *sugar;* 0·2 of *lactic acid;* 0·5 of *inorganic salts;* and a trace of *free,* CO_2.

Cider and *Perry* are the fermented juices of the apple and pear respectively.

Beer, Ale, Stout or *Porter,* are fermented infusions of malt flavoured with hops. The dark colour of the latter is due to the use of roasted malt.

The various kinds of Wine are produced by the spontaneous fermentation of the juice of the grape. They owe their peculiarities to the different varieties of grape. When the fermentation is allowed to proceed until the whole of the sugar is removed, the resulting wine is "dry." This is the case with claret, Burgundy, and the wines of the Rhine and Moselle. Others, however, yield a variable amount of sugar; thus sherry contains from 1 to 5 per cent. of sugar, port from 3 to 7, and tokay as much as 17 per cent. In "ripening" wines lose this sugar by a slow process of fermentation, and as its place is supplied by alcohol, the saline matters (argol chiefly, see p. 140) are gradually deposited upon the dependent side of the bottle, forming the "crust."

If the fermentation be checked before the sugar is nearly all decomposed, a sweet, full-bodied, fruity wine results. If the wine be bottled while the fermentation is still in process an effervescent or sparkling wine is obtained. Cane sugar is usually added to champagne and cider at the time of bottling.

The acidity of wine properly prepared is due to the acid tartrate of potash, and as this is deposited *pari passu* with the progress of fermentation, an old wine should contain but little acid. But if in the making of the wine air has not been properly excluded towards the end of the process, acetic acid is formed, and this not removed by age.

By allowing the skins of the red or purple grape to remain in the fermenting liquor, astringent as well as the colouring matter is removed by the spirituous liquor, and it is thus that clarets and ports obtain their colour and astringent character.

The proportion of alcohol varies according to the sweetness of the grape. It may be readily ascertained by the addition of perfectly dried carbonate of potash to the wine or spirituous liquor contained in a graduated tube. The salt dissolves in the water, and forms a heavy layer, upon which alcohol of sp. gr. 0·825 accumulates, and the volume is read off (Brande).

Christison obtained the following results by distillation. The numbers represent the weight of absolute alcohol in 100 parts of the liquor:—

Port,	from	14·9 to 17	Amontillado,	from	12·6
Lisbon,	,,	16·1	Claret,	,,	7·7 to 8·9
Madeira,	,,	14·0 to 16·9	Hambacher,	,,	7·3
Sherry,	,,	13·9 to 16·9	Rudesheimer,	,,	6·9 to 8·4
Teneriffe,	,,	13·8	Edinburgh Ale,	,,	5·7 to 6
Shiraz,	,,	12·9	London Porter,	,,	5·3
Malmsey,	,,	12·8			

Action.—The action of fermented liquors depends chiefly upon the alcohol and its amount, but each has its own proper action besides. Brandy and whisky differ but little from alcohol, containing the same amount of water, but experience appears to show that whisky may be taken for a longer period than brandy before the effects of abuse appear; this difference is probably due to the more rapid elimination of the latter by the kidneys. Gin is diuretic by virtue of the juniper which it contains, and the diuretic properties of whisky may be attributed to traces of volatile oil. The abuse of ardent spirits causes chronic irritation of the liver, leading to induration and shrinking, an effect which may fairly be regarded as due to the direct action of the spirit on the liver. Wine does not have the same effect, probably because the alcohol contained in it does not exceed 17 per cent. It is remarkable with regard to wine, that its intoxicating action is less than that of a mixture of water and an equivalent quantity of alcohol, while its stimulant action is more slowly developed and more persistent. This valuable quality of wine is no doubt due to the comparative slowness with which it permeates the absorbents. In spirituous liquors, which very rapidly permeate the stomach, the alcohol is free; in wine it may be fairly assumed that some portion is combined with its saline and organic matters, and that its passage through the mucous membrane is retarded by this combination.

The abuse of wine, or even a very moderate use in those who have a strong rheumatic or gouty tendency, leads to the formation of excess of uric acid, and this is especially noticeable in the use of full-bodied wines, such as young port, or acid wine such as Madeira—the effect, however, being altogether disproportionate to the quantity of sugar or free acid which the wine may contain. We must, therefore, be careful to prescribe a light and dry wine for rheumatic and gouty patients, if we have need to prescribe the beverage at all for them. The same remarks apply to malt liquors, which are never long tolerated by persons with the tendencies just mentioned. The habitual use of these saccharine beverages leads to an increase of fat, and they are on this account serviceable aids to recovery from the emaciation which attends protracted illness. The abuse of malt liquors leads to a fatty condition of the blood and parenchymatous organs, a liability to inflammatory diseases, and an inability to resist them. Cider is "heating," doubtless on account of the large quantity of malic and often acetic acids which it contains; and it is both diuretic and diaphoretic. Diuretic properties are even more marked in perry. It is doubtful what influence these beverages have in the production of the chronic rheumatic affections so notably preponderant in our cider-growing districts, since these have a damp, heavy clayey soil, which is of itself an element in the production of rheumatism.

ÆTHER.

Vinic Æther. Æther Sulphuricus.

A volatile liquid prepared from alcohol, and containing not less than 92 per cent. by volume of pure æther, C_4H_5O or $(C_2H_5)_2O$.

Preparation.—Mix 10 fluid ounces of *sulphuric acid* with 12 fluid ounces of *rectified spirit* in a glass matrass (*a*, fig. 58) of at least two pints capacity, and while the mixture is still hot adapt the matrass to a Liebig's condenser, and distil with a heat sufficient to maintain the liquid in brisk ebullition. As soon as the ætherial fluid begins to pass over, supply fresh spirit in a continuous stream by means of a tube passing through a cork in the matrass, and communicating with a reservoir of spirit, *b*, on a higher level, and furnished with a stop-cock to regulate the flow, so that the quantity of alcohol admitted may equal that of the ætherial fluid distilled. When 38 fluid ounces of spirit have been thus added, and 42 fluid ounces have distilled over, the process may be stopped. Agitate the impure æther in a bottle with 10 ounces of *chloride of calcium* dissolved in water, and mixed with half an ounce of *slacked lime.* Leave the mixture at rest for ten minutes, then pour off the supernatant fluid, and distil it with a gentle heat until a glass bead of sp. gr. 0·735 placed in the reservior begins to float. The æther and spirit retained by the chloride of calcium and by the residue of each rectification may be recovered by distillation, and used in a subsequent operation.

In the above process it is found that the same portion of sulphuric acid will convert an indefinite quantity of alcohol into æther. This is due to the decomposing action of alcohol on sulphovinic or sulphæthylic acid, a compound corresponding in constitution to bisulphate of potash, and always formed when a mixture of alcohol and sulphuric acid are heated to about 212°, thus: $C_2H_5HO + H_2SO_4 = C_2H_5HSO_4$ (sulphæthylic acid) $+ H_2O$. The effect of the sulphuric acid is to convert the alcohol into the radicle æthyl (C_2H_5) by the separation of an equivalent of water. This occurs in the first stage of the process above described, and when fresh alcohol is brought in contact with the boiling mixture of sulphæthylic acid and water, it immediately decomposes the former into æther and sulphuric acid, thus: $C_2H_5HSO_4 + C_2H_5HO = (C_2H_5)_2O + H_2SO_4$. The æther produced now, and the water formed previously, distil over; the sulphuric acid, which remains in the matrass, combines with a fresh portion of alcohol to reform sulphæthylic acid, to be decomposed as soon as it comes in contact with fresh alcohol, and so the process continues until the supply of alcohol is exhausted, or the sulphuric acid becomes too dilute to react on the alcohol to form sulphæthylic acid.

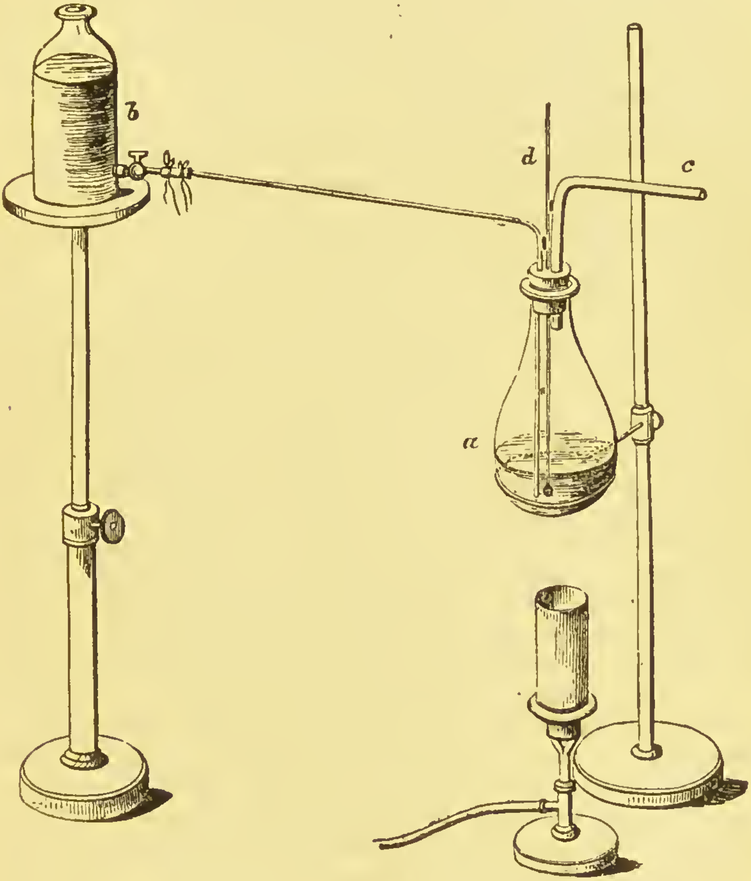

Fig. 58.

Characters and Tests.—A colourless, very volatile, and inflammable liquid; sp. gr. 0·735; boiling below 105°; emitting a strong and characteristic odour. 50 measures agitated with an equal volume of water are reduced to 45 by an absorption of 10 per cent. It evaporates without residue, and should be neutral to test paper. If the sp. gr. and boiling point be higher than the numbers given above, the æther contains alcohol or water, or both.

Uses.—1. *Medicinal* (see Pure æther). 2. *Pharmaceutical.*—To separate calomel and corrosive sublimate, the red and green iodides, and the black and red oxydes of mercury. It is employed in the following preparations :—Æther purus, Collodium and C. flexile (6 volumes in 8 nearly), Liquor epispasticus (4 volumes in 5 nearly), Spiritus ætheris (1 volume in 3).

1. **Æther Purus**, *P.B.* *Pure Æther.*

C_4H_5O or $(C_4H_5)_2O$. Sp. gr. of vapour, 2·586.

Preparation.—The Pharmacopœia directs the following process for the removal of the alcohol and water which is contained in the impure æther described above:—Two pints of *æther* are shaken in bottle with a pint of *water;* the æther is then allowed to separate, decanted, and washed with another pint of water. The æther thus separated from the alcohol is again decanted, and placed in a retort to which a receiver is closely attached, with 4 ounces of *chloride of calcium* and ¼ of an ounce of recently *burnt lime.* After standing for 24 hours the æther is distilled by the aid of a gentle heat. The sp. gr., which should not exceed 0·720 at 60°, and freedom from acidity, are the indications of the purity of this liquid.

Characters.—Anhydrous or absolute æther, free from alcohol, has the sp. gr. of 0·7365 at 32°, and 0·72 at 60°. It boils at 94°·8, and remains liquid at – 146°. It is neutral when freshly prepared, but on exposure to air and light it becomes acid. Æther evaporated very rapidly produces a considerable reduction of temperature. The vapour is two and a-half times heavier than air, with which it forms an explosive mixture. It should not, therefore, be poured from one vessel to another in the vicinity of flame. One volume of æther vapour requires for combustion 6 volumes of oxygen, the product being 4 volumes of carbonic acid and 5 of aqueous vapour. If a coil of platinum wire be heated red hot and placed in a mixture of æther vapour and air, the platinum continues to glow at the expense of the heat generated by the oxydation of the æther, which is converted into acetic and formic acids, and aldehyd. This change takes place slowly and to a limited extent when æther is exposed to air and light, as occurs when bottles in which it is preserved are only partly filled. It is miscible with alcohol in all proportions, dissolves $\frac{1}{36}$ of its volume of water, and is soluble in 8 times its bulk of that liquid. Next to chloroform, it is the best solvent for the separation of the vegetable alkalies. It extracts in a similar way corrosive sublimate, perchloride of gold, perchloride of iron, and perchloride of platinum from their watery solutions, and when left at rest carries the two former compounds to the surface. It dissolves fatty and resinous substances, the volatile oils, india-rubber, gun-cotton, urea, iodine, and bromine. Sulphur and phosphorus are but sparingly soluble in æther.

Action.—The action of alcohol, æther, and of chloroform appears to be identical. The vapour of æther is half the weight of that of chloroform, and on this account it may be regarded as the more readily diffusible stimulant of the two. It may be taken in very much larger doses than chloroform. Dr Christison states, that "an asthmatic patient took every eight or ten days 16 ounces of æther for many years without impairment of health; and a dram-drinker has been known to take seven drachms at once with impunity" (*Med. Gaz.* xxxix. p. 715). As a *diffusible stimulant* it is a valuable remedy. As a general *anæsthetic* it was employed in America as early as 1846, where it is still largely used in preference to chloroform. In this country it has been altogether superseded by chloroform; and the cause of it is to be found mainly in the two facts, that chloroform produces anæsthesia more rapidly than æther, and that its vapour is more agreeable than that of æther. Objections founded on the inflammability of the vapour of æther and the large quantity required to produce anæsthesia, are merely acknowledgments that the apparatus which have been employed in the inhalation are defective. Experience has proved that narcosis can be much more safely induced with æther than with chloroform, the rapid action of which not unseldom causes death during the first minute of its inhalation from direct pulmonary asphyxia. The action of æther is too slow ever to produce this direct effect. Nor is the danger averted or diminished in the first stage of the inhalation only, but also when complete narcosis is induced; for it appears that æther does not possess that deep paralysing power over the respiratory movements which renders chloroform so formidable.

In order to avoid a prolonged period of excitement, it is essential in the administration of æther that the air should be sufficiently charged with its vapour; and in order to effect this, means must be adopted for excluding the air to a much greater extent than in chloroform inhalation. A similar arrangement to that described for the inhalation of chloroform may be adopted; but the mask should be conical, and fitted with a large sponge, communicating externally at the apex; the edge of the mask padded, to fit the face evenly, and the whole enveloped by a well-fitting coat of double flannel. From 4 to 8 fluid drachms of pure æther are poured upon the sponge, and the apparatus is applied to the patient's face. In this way anæsthesia may be induced in from 1 to 4 minutes. By means of a little tube fitted to the wire cage opening just within its lower border, and furnished externally with a mouth-piece, the operator may ascertain from time to time the condition of the air in the cone, and, if need be, pour more æther upon the sponge exposed at the apex.

2. **Spiritus Ætheris,** *P.B.* *Spirit of Æther.* Sp. gr. 0·809.

A mixture of 1 volume of æther and 2 volumes of rectified spirit. The sp. gr. is the test of its purity. It is miscible with water in all proportions.

Dose.—30 to 90 minims.

Pharmaceutical Use.—The preparation of Tinctura lobeliæ ætherea.

3. **Spiritus Ætheris compositus.** *Compound Spirit of Æther.*

A mixture of 8 fluid ounces of æther, 16 fluid ounces of rectified spirit, and 3 fluid drachms of ætherial oil (*Pharmacopœia Londinensis*).

Action and Uses.—This has been long used under the name of *Hoffman's Anodyne*, as an adjunct to opiates. It resembles the previous preparation in its action, but is somewhat more anodyne.

Dose.—½ to 2 fluid drachms.

OLEUM ÆTHEREUM. *Æthereal Oil*, or *Heavy Oil of Wine.*

This is sulphuric æther or sulphate of æthyl $(C_2H_5)_2SO_4$ mixed with variable proportions of other oily hydrocarbons, polymeric with olefiant gas. It is formed towards the close of the distillation of æther.

Preparation.—Mix 36 fluid ounces of *sulphuric acid* cautiously with 2 pints of *rectified spirit*, and distil until a black froth appears, when the heat must be instantly withdrawn. Æther, water, sulphurous acid, and a supernatant oily liquid pass over. The latter is separated, exposed to the air for a day to free it of æther, and then washed with a fluid ounce of solution of potash mixed with an equal quantity of water. A little æthrole (light oil of wine, C_2H_4) isomeric with olefiant gas, and sulphæthylate of potash are produced by the action of the aqueous potash.

Characters.—A yellowish, oily-looking liquid, of sp. gr. 1·05; of a bitter taste and aromatic odour, neutral to test paper. It is insoluble in water, and when dropped into it, falls to the bottom at once, and preserves a globular form. It is freely soluble in æther and in alcohol. When boiled with water it is resolved into sulphæthylic acid (see p. 330) and ætherol.

Action.—Hypnotic and anodyne.

Pharmaceutical Use.—An ingredient of the previous preparation.

ÆTHER ACETICUS, *P.B.* *Acetic Æther.*

$C_4H_5O,C_4H_3O_3$ or $C_2H_5C_2H_3O_2$.

May be obtained by distilling a mixture of 8 parts of dry acetate of soda, 5 parts of rectified spirit, and 10 parts of sulphuric acid, adding the distilled product to half its weight of chloride of calcium in a stoppered bottle; letting them remain together for twenty-four hours, and then decanting and rectifying the ætherial fluid.

In this process the sulphuric acid simultaneously converts the alcohol into æther and liberates acetic acid, and the two combine to form acetic æther, which distils with some water. This is removed by the chloride of calcium.

Characters.—A colourless volatile liquid, with an agreeable cider-like odour; sp. gr. 0·910; boiling point 166°. Miscible with alcohol and æther in all proportions. Soluble in 11 or 12 parts of water at 60°. An alcoholic solution of caustic potash converts it immediately into acetate of potash and alcohol.

Action and Uses.—It resembles æther in its action, but is milder, pleasanter, and has a more decidedly diaphoretic action. It is an appropriate adjunct to acetate of ammonia. It is a good solvent for resins, essential oils, and gun cotton.

Dose.—20 to 60 minims.

SPIRITUS ÆTHERIS NITROSI, *P.B.* *Spirit of Nitrous Æther.*

A spiritous solution containing nitrous æther, C_4H_5O,NO_3 or $C_2H_5NO_2$.

Preparation.—To 1 pint of *rectified spirit* add gradually 2 fluid ounces of *sulphuric acid*, stirring them together; then add gradually 2½ fluid ounces of *nitric acid.* Put the mixture into a retort with 2 ounces of fine *copper wire* (about No. 25). Insert a thermometer, and attach an efficient condenser, and applying a gentle heat, let the spirit distil, commencing at 170° and raised to 175°, but not exceeding 180°, until 12 fluid ounces have passed over into a receiver, cooled if necessary with iced water; then allow the contents of the retort to cool; introduce ½ ounce more of nitric acid, and resume the distillation as before until the distillate measures 15 fluid ounces. Mix this with sufficient (about 2 pints) rectified spirit to make the product correspond to the tests given below. Preserve in well-closed vessels.

Sulphæthylic acid is formed, and water liberated, as in the preparation of æther.

The copper, by reducing the nitric acid to nitrous acid, initiates the process, and by making it more equable, hinders the formation of aldehyd (Redwood). The nascent æthyl unites as fast as it is formed with the nitrous acid, producing nitrous æther, which distils over with a portion of the alcohol, and is still further diluted by the addition of more. The whole process may be represented in one formula, thus:

$$C_2H_5HO + HNO_3 + Cu + H_2SO_4 = CuSO_4 + 2H_2O + C_2H_5NO_2 .$$

If the temperature rise too high, or if the proportion of nitric acid to the alcohol be greater, the action becomes more intense and complicated, and aldehyd, amongst other products, is largely developed. A small portion of the compound is liable to be formed even when the prescribed process is carefully followed.

Characters and Tests.—Transparent and nearly colourless, with a very slight tinge of yellow; sp. gr. 0·845; mobile, inflammable, of a penetrating apple-like odour, and sweetish, cooling, sharp taste. It effervesces feebly or not at all when shaken with a little bicarbonate of soda (absence or mere trace of acid). Agitated with solution of sulphate of iron and a few drops of sulphuric acid, it becomes deep olive-brown or black (test for nitric oxyde, see p. 72). When agitated with twice its volume of saturated solution of chloride of calcium in a closed tube, 2 per cent. of its original volume will separate in the form of nitrous æther, and rise to the surface of the mixture (indicating the presence of about 10 per cent. by volume of nitrous æther in the alcoholic solution).

Nitrous æther is very unstable in the presence of water, nitric, oxalic, acetic, formic, glycolic, glyoxalic acids, and several aldehyds being formed (Debus, *Phil. Mag.* 1856). Hence it is desirable to prescribe it alone, and direct the patient to add a given quantity to the draught containing the other medicines which we may wish to prescribe.

Action and Uses.—A stimulant diaphoretic and diuretic; useful in febrile disorders and in dropsy, especially in children, who are much more readily influenced by its action than adults. It is commonly combined with salines, squill, and opium.

Dose.—½ to 2 fluid drachms.

METHYLIC ALCOHOL. *Wood Spirit.*

$C_2H_3O,HO = 32$ or $CH_4O = 32$.

This, like tar and acetic acid, is a product of the destructive distillation of wood. The fluid which first comes over contains the spirit which, after two rectifications, constitutes *pyroligneous æther* or *wood naphtha*,—a fluid quite distinct from mineral naphtha (see "Petroleum"), which is a simple hydrocarbon. This impure spirit is much used in the arts as a solvent for resins and fuel for lamps. It has a peculiar smoky odour and taste, due to acetone, acetate of methyl, and other volatile hydrocarbons. To free it from these it is saturated with chloride of calcium, with which methylic alcohol combines to form $CaCl_2CH_4O$, crystallising in six-sided tables, and stable at 220°. The mixture is then subjected to the heat of a steam bath, by which the volatile impurities are expelled. The residue is mixed with water, which sets the wood spirit free from its combination with the chloride of calcium, and is again exposed to the steam bath, when the spirit distils with a little water. A second rectification from quicklime gives the pure spirit.

Characters.—A colourless, very inflammable neutral liquid, of sp. gr. 0·8179 at 32°; boils between 140° and 149°; has a penetrating spirituous odour, and an unpleasant burning taste.

Like æthylic alcohol, it dissolves the caustic alkalies, but they immediately colour it brown, and this is employed as a test of its presence in ordinary alcohol.

Action and Uses.—Its properties are those of ordinary alcohol, over which it possesses no advantage. It is used in the preparation of the following:—

1. **Methylated Spirit.**

A mixture of alcohol, of sp. gr. 0·830, with 10 per cent. of methylic alcohol. The admixture of wood spirit does not interfere with the solvent and other useful properties of the alcohol, while it prevents, to a great extent, the use of the mixture as a stimulant drink. The disagreeable odour may be removed by prolonged contact with charcoal (Eschwege).

Uses.—A solvent for resins and a fuel for the spirit lamp. It is unsuitable for the preparation of tinctures, or even liniments, as the taste and odour are very persistent and disagreeable. It is said to be generally used in the preparation of chloroform, æther, and nitrous æther.

Trimethylia or *Trimethylamine*, C_3H_9N.

This alkaline fluid, which may be regarded as ammonia in which the 3 atoms of hydrogen are removed and replaced by 3 of methyl (CH_3), has been advocated on the Continent as a remedy for rheumatism and gout.

It is a very volatile liquid, boiling at 41°, and emitting a powerful fishy odour.

It exists in considerable quantity in the roe of herrings, and may be obtained by distilling herring brine or ergot of rye with lime or potash. *Chenopodium vulvaria* owes its peculiar odour to this body.

Liquid methylia is readily converted into the solid chloride by neutralising hydrochloric acid with it and crystallising.

Action and Use.—On account of its strong alkalinity, and on the theory that it is capable of transforming the acid products which are formed in the blood in the rheumatic and gouty diathesis into harmless amides, it has been recommended in these conditions. It appears to exert a well-marked diuretic action.

Dose.—4 to 8 minims of trimethylia in an ounce or two of aromatic water, or 10 to 15 grains of the chloride.

Bichloride of Methylene, or *Chloride of Mono-chlor-methyl.*
$C_2H_2Cl_2$ or CH_2Cl_2.

This, a substitution product of the first of the alcoholic series, is prepared by liberating hydrogen from granulated zinc and dilute sulphuric acid in contact with chloroform:

$$CHCl_3 + H_2 = HCl_2 + CH_2Cl_2.$$

It is a colourless limpid fluid, of sp. gr. 1·344, of the vapour 2·9, with an odour like that of chloroform; boils at 88°; the vapour is inflammable.

It is difficult to obtain a pure compound, and a mixture of æther and chloroform is said to have been fraudulently substituted for it.

Action and Uses.—The vapour has been used for the production of anæsthesia, but experience has shown that it has no advantage over chloroform, and that it is not so safe as æther. As an antispasmodic, 15 to 30 minims may be taken internally.

Aldehyd, or *Acetic Aldehyd.* $C_4H_4O_2$ or C_2H_4O.

A few words respecting this active derivative of alcohol (*Al*-cohol *dehyd*-rogenated) is necessary here, in order to the clear understanding of the formation and constitution of the chlorine compounds next following.

Aldehyd is best prepared by distilling a mixture of alcohol, sulphuric acid, and black oxyde of manganese. Manganous sulphate is formed, and the liberated atom of oxygen of the binoxyde combines with 2 atoms of the hydrogen of the alcohol to form water, and aldehyd thus formed distils: $C_2H_6O + O = H_2O + C_2H_4O$.

It is a volatile, inflammable liquid, of sp. gr. 0·8 at 32°, and a remarkably pungent and irritating but fruity odour, a little resembling that of apples. It cannot be exposed to the air without absorbing oxygen and forming acetic acid. In contact with potash it is resolved into acetic acid and hydrogen: $C_2H_4O + KHO = KC_2H_3O_2$ (acetate of potash) $+ H_2$. By a similar action, and in the presence of a little free ammonia, it reduces the salts of silver with the deposition of a brilliant film of the metal. In contact with a saturated solution of sodic formiate two molecules lose one of water and undergo condensation, to form C_4H_6O, or aldehyd of crotonic alcohol (C_4H_8O) (see p. 346).

The substitutive action of chlorine upon these versatile aldehyds is well seen in the following compounds:—

CHLOROFORM, *P.B.* *Chloroform.*

C_2HCl_3 or $CHCl_3$. Density of vapour 4·2.

Chloroform was discovered by Soubeiran in 1832; analysed by Dumas in 1834; used as an anæsthetic in 1847, at the suggestion of Mr Furnell, by Lawrence and Holmes Coote in London, and introduced for the same purpose into obstetric practice by the late Sir J. Simpson.

Chloroform was formerly obtained by the action of caustic alkalies on chloral (see p. 343). It is now more readily prepared by distilling diluted alcohol with chlorinated lime.

Preparation.—Mix 30 fluid ounces of *rectified spirit* with 3 gallons of *water* in a capacious still; add 10 pounds of *chlorinated lime* thoroughly mixed with 5 pounds of *slaked lime.* Let the condenser terminate in a narrow-necked receiver, and apply heat so as to cause distillation, taking care to withdraw the fire the moment the process is well established. When the distilled product measures 50 ounces remove the receiver and pour its contents into a gallon bottle half filled with water, shake well together, and set at rest for a few minutes, when the chloroform will subside; pour off the water, and thrice wash the chloroform in a smaller vessel with successive portions (3 ounces) of water; agitate the washed chloroform for five minutes with an equal volume of *sulphuric acid*, then, after subsidence of the latter, transfer the chloroform to a flask containing 2 ounces of *chloride of calcium* in small fragments, mixed with ½ ounce of perfectly dry slaked lime. Mix well by agitation. After the lapse of an hour connect the flask with a Liebig's condenser, and distil the pure chloroform by means of a water bath. Preserve the product in a cool place in a well-stoppered bottle. The lighter liquid which floats on the crude chloroform after its agitation with water, and the washings with distilled water, should be preserved and employed in a subsequent operation.

Chlorinated lime, by virtue of the hypochlorite contained in it, is a powerful oxydising agent (see p. 157), and the first step in the above process consists in the oxydation and removal of 2 atoms of hydrogen from the alcohol, and its conversion into aldehyd, thus: $C_2H_6O + O = H_2O + C_2H_4O$. The aldehyd thus formed is immediately attacked by the chlorine and converted into hydrochloric acid and trichloraldehyd or chloral (see p. 343), thus: $C_2H_4O + 6Cl = 3HCl + C_2HCl_3O$. The third and last stage consists in the decomposition of the chloral by caustic lime and its conversion into formic acid and chloroform: $2(C_2HCl_3O) + CaH_2O_2 = Ca2CHO_2 + 2CHCl_3$ (see also p. 343). The hydrochloric and formic acids thus formed in the process unite with the lime to form chloride and formiate, which remain in the retort. The crude product is contaminated with a little alcohol and volatile hydrocarbons. These are removed by agitation with sulphuric acid. It is necessary that the acid used for this purpose should be pure and free from nitric or nitrous acid, for contact with the latter makes the chloroform unstable, so that if it be kept long, or freely exposed to the light, hydrochloric acid and chlorine are formed, giving the liquid a suffocating and irritant odour, and thus rendering it unfit for use.

Characters and Tests.—A limpid, colourless liquid, of sp. gr. 1·49; an important character, proving the absence of alcohol or æther, the former of which is the commonest impurity; boiling at 140°; neutral to test papers. The absence of hydrochloric acid, which may be present from decomposition, is indicated by this character. Very volatile, of an agreeable ætherial odour, and sharp, sweet taste. Dissolves in alcohol and in æther in all proportions; slightly soluble in water (about 1 vol. in 200), communicating to it a sweet taste and apple-like odour. It burns, though not readily, with a green and smoky flame. It is not coloured by agitation with sulphuric acid, nor does it leave any residue or unpleasant odour after evaporation (showing the absence of chlorinated oily matters).

Chloroform is a ready solvent for India-rubber, wax, camphor, and the volatile oils, sulphur, phosphorus, iodine, bromine, and the vegetable alkaloids. It readily separates the latter, as well as iodine and bromine, from aqueous solutions. Chloroform may be distilled unchanged with sulphuric or nitric acids or caustic potash; but mere admixture with an alcoholic solution of the latter results in the formation of chloride and formiate of potassium.

Action and Uses.—Given in the fluid form (from 10 to 20 minims dissolved in alcohol or water), it is a stimulant and antispasmodic, producing slight feelings of alcoholic intoxication. In larger doses (20 to 40 minims) the stimulant effect gives way to drowsiness and sleep. In still larger doses, stertorous sleep, or actual coma, rapidly comes on, with dilated pupils and flaccidity of the muscles; depression of the respiratory and cardiac movements, and consequently of the temperature. Recovery has taken place after the ingestion of 4 ounces (Pereira). It has not yet been determined in what form chloroform is eliminated, but a substance is present in the urine which reduces an alkaline solution of oxyde of copper.

Inhalation of the vapour produces, after two or three full inspirations, a diffusion of warmth and numbing or tingling from the chest to the extremities, a pleasant feeling of exhilaration, and unsteadiness, soon accompanied by a noisy vibratile sound in the head, which quickly increasing in rapidity and intensity absorbs all the attention, and threatens a climax. Mental and motor excitement frequently ensues at this stage, and the patient may talk deliriously, shout, or sing, and often struggles violently. If the inhalation be continued, narcosis, attended by complete muscular relaxation, follows in from one to ten minutes. If the narcosis be complete, there is complete anæsthesia, and the reflex action of the orbicularis can no longer be excited by touching the eyeball. In the early period of the inhalation the pulse is accelerated, but after sleep or narcosis is induced, it usually falls to 70 or 65 without any appreciable change in volume or power. The pupils are moderately dilated, and the face, if it has not retained the flush caused by the period of excitement, is usually pale. If the inhalation be now stopped the patient will remain calmly sleeping in a state of anæsthesia for a variable period, and then rather suddenly awake. This event is often determined by vomiting, which is apt to come when a meal has been taken but a short while before. The narcosis may be maintained for an hour or more by allowing the patient to inspire the diluted chloroform vapour at intervals of a few seconds at a time. Some stertor often attends the narcosis.

In poisonous doses the pulse falls rapidly, the breathing becomes intermittent, or slow and shallow, the face assumes a corpse-like pallor, the lips are livid, the pupils widely dilated. Respiration now ceases, the pulse is no longer perceptible, and the patient is dead. In some of the fatal cases death has occurred a minute after inhalation has commenced, and when not more than 20 minims of chloroform have been used. Death results from pulmonary asphyxia or collapse, followed by accumulation of blood in the great veins of the chest and the right cavities of the heart. If the heart be speedily relieved of this injurious pressure its action is restored. The effects are brought about in two ways:—1. The presence of chloroform in the blood affects the red corpuscles, diminishing their absorbent power for oxygen, and producing their partial deliquescence and disintegration, whereby the serum assumes a pink tinge, and furnishes crystals of hæmoglobin when evaporated on a glass slide. Sluggish capillary flow, with increased arterial pressure—in a word, partial asphyxia—is the result of this action on the blood. 2. The respiratory movements share in the depression of the motor function, and a feeble action of the diaphragm concurs in the primary asphyxiating influence of the chloroform. It is clear, therefore, that death results from the simultaneous action of the chloroform on the blood and the respiratory movements. These facts suggest the following precautions in the induction of chloroform narcosis:—*First*, as to the condition of the patient. The expansion of the chest should be good, and the apex stroke of the heart in its normal position, and palpable on full expiration in moderately thin people, while it should be distinctly audible in all. The stomach should be empty, and the abdominal viscera free from such disease as would cause dyspnœa by impeding the action of the diaphragm. It must be remembered that impeded capillary circulation imposes a great strain on the heart, and if its structure be naturally weak, or rendered so by fatty degeneration, syncope—fatal under the condition of partial asphyxia induced by the chloroform—is liable to occur from mere pressure of the blood. Of the 56 cases in which the heart was examined, it was normal in only 21. It was pale, soft, and flabby in 14; loaded with external fat in 2; fattily degenerate in 14; and there was valvular disease in 2 (Sansom, *On Chloroform*, p. 76). Patients, therefore, in whom there is excessive obesity with weak action of the heart and tendency to œdema, and those who are the subjects of emphysema, capillary bronchitis, and presumably a fatty heart, cannot be safely subjected to complete chloroform narcosis. *Secondly*, as to the administration of the vapour and the degree of narcosis. The best form of inhaler is an open wire mask shaped like a dish-cover. The upper and lower borders fitted to the forehead and the chin, and the bottom of the convexity fitted with a small sponge about three fingers wide. The patient being free from all restraints of dress, from ½ to 1 drachm of chloroform is poured on the sponge, and the mask is placed on the face, and a folded handkerchief thrown over it. By this means a due admixture of air is secured, and there is no danger, as may happen when a handkerchief alone is used, of the heavy chloroform vapour flowing directly into the respiratory passages, from too close an approximation of the part wetted with the chloroform. The fingers should remain on the pulse, and the eyes be steadily directed to the chest and face during the whole of the process. As soon as the eyeball can be touched without inducing a wink, the inhalation must be stopped, and resumed as occasion requires, the condition of the reflex action of the orbicularis being the guide. Should the pulse suddenly fall or the inspiration fail, or if there be much stertor and relaxation of the sphincters, the patient must be turned on the side, the tongue drawn forwards, and artificial respiration induced by alternately compressing the abdomen at the same time that the arms are forcibly abducted, and the chest. Every means for arousing the respiratory function should always be accessible.

It is to be observed that death may occur at any period of the inhalation, and it is remarkable that in 50 out of 109 cases, the fatal event took place before the patient was under the full influence of the chloroform, and in $\frac{1}{11}$ of the cases before the first minute had elapsed (*Med. Chir. Trans.* vol. xlvii.) The Austrian Government direct the use of a mixture of chloroform and æther, and it would appear to be safer than chloroform alone, for no death has occurred from its use in Vienna. This is no doubt chiefly attributable to the greater levity of the vapour. The proportions employed are 1 part of chloroform to 6 parts of æther in cold weather, and 8 parts in summer.

Uses.—As an *anæsthetic* in surgical operations, and during the last stage of labour. As a *muscular relaxer* in hernia and dislocations of the limbs; in tetanus, and the tetanic convulsions induced by strychnia; in the convulsions of children. In these convulsive affections, however, conium is the more appropriate remedy, and chloroform is better adapted to the treatment of hydrophobia and violent maniacal excitement. Internally it is generally employed as an antispasmodic; and externally as an anodyne, as in neuralgia and especially odontalgia.

Dose.—3 to 15 minims dissolved in spirit and diluted with water. As an inhalation from 20 minims given with the preceding precautions.

Pharmaceutical Uses.—In the preparation of Liquor gutta-percha, and the 4 articles next following:—

1. **Aqua Chloroformi**, *P.B.* *Chloroform Water.* 1 volume in 200.

Preparation.—Mix 1 fluid drachm of *chloroform* and 25 ounces of *water* in a quart stoppered bottle, and shake the mixture until the chloroform is entirely dissolved.

Dose.—½ to 2 fluid ounces.

2. **Spiritus Chloroformi**, *P.B.* *Spirit of Chloroform.* 1 volume in 20.

A mixture of 1 fluid ounce of *chloroform* and 19 fluid ounces of *rectified spirit.*

Test.—Sp. gr. 0·871.

Dose.—20 to 60 minims.

3. **Tinctura Chloroformi composita**, *P.B.* *Compound Tincture of Chloroform.* 1 volume in 10.

A mixture of 2 fluid ounces of *chloroform*, 8 fluid ounces of *rectified spirit*, and 10 fluid ounces of *compound tincture of cardamoms.*

Dose.—20 to 60 minims.

4. **Linimentum Chloroformi**, *P.B.* *Liniment of Chloroform.* 1 volume in 2.

A mixture of equal volumes of *chloroform* and *liniment of camphor.*

IODOFORMUM. *Iodoform.* C_2HI_3 or CHI_3.

It is a yellow solid, and corresponds in composition to chloroform, 3 atoms of iodine in the former occupying the place of the chlorine in the latter.

It is prepared by adding to an alcoholic solution of iodine an alcoholic solution of potash until the mixture is yellow. The liquid is then distilled to dryness, and the residue treated with water, which dissolves out iodide of potassium and formiate of potash. Iodoform is insoluble in water, but freely soluble in alcohol, æther, and in oils.

Action. Uses.—The action is that of a salt of iodine, for which it is substituted in bronchocele and syphilitic and scrofulous diseases.

Dose.—½ to 2 grains in alcohol.

CHLORAL HYDRAS, *P.B.*

$C_4HCl_3O_2,2HO = 165·5$ or $C_2HCl_3O,HO_2 = 165·5$.

Hydrate of chloral was introduced as a therapeutic agent by Dr Liebreich of Berlin a few years ago, since which time it has come into general use. Chemists have long regarded chloral with interest on account of its relation to aldehyd on the one hand, and chloroform and formic acid on the other. It is, in fact, aldehyd in which 3 atoms of hydrogen are *dis*placed by 3 atoms of chlorine to form 3HCl, and *re*placed by 3 other atoms of chlorine. Hence the synonym *trichloraldehyd*, thus:—

$$\underset{\text{Aldehyd.}}{C_2H_4O} + 6Cl = \underset{\text{Chloral.}}{C_2HCl_3O} + 3HCl.$$

Chloral, however, is not produced directly from aldehyd, but by the action of *dry* chlorine on *anhydrous* alcohol, which is subjected to a stream of the gas as long as it is absorbed. At first it is necessary to keep the alcohol cool, but afterwards the temperature is gradually raised until it boils. Large quantities of hydrochloric acid are continuously evolved. The crude product is mixed with thrice its bulk of monohydrated sulphuric acid and distilled. This operation must be repeated, and the chloral finally distilled over quicklime. 8 atoms of chlorine are required for the decomposition of 1 molecule of alcohol, which is first of all converted into aldehyd by the removal of one-third of its hydrogen, thus:—

$$\underset{\text{Alcohol.}}{C_2H_6O} + 2Cl = \underset{\text{Aldehyd.}}{C_2H_4O} + 2HCl.$$

The aldehyd is now attacked by fresh chlorine, and three-fourths of its hydrogen removed and replaced by chlorine: $C_2H_4O + 6Cl = C_2HCl_3O + 3HCl$. Thus 5 out of the 6 atoms of the hydrogen of the alcohol are removed and converted into 5 of hydrochloric acid, in the production of every equivalent of chloral; affording an admirable illustration both of the reducing action of chlorine, and its power in forming substitution compounds, by virtue of its great affinity for hydrogen.

Chloral thus formed is an oily-looking fluid of sp. gr. 1·502, of an ætherial penetrating odour; soluble in water, alcohol, and æther. An alcoholic solution of potash immediately converts it into chloroform and formiate of potash, thus:—

$$\underset{\text{Chloral.}}{C_2HCl_3O} + KHO = \underset{\text{Formiate of potash.}}{KCHO_2} + \underset{\text{Chloroform.}}{CHCl_3}.$$

Mixed with a small quantity of water chloral is converted, with the extrication of much heat, into crystalline *hydrate of chloral.*

Characters and Tests.—In colourless crystals (needles, or acute rhomboidal plates), which do not deliquesce on exposure to the air. It has a pungent, but not acrid odour, resembling that of pears. A pungent and rather bitter taste. On the application of a gentle heat it fuses to a colourless liquid, which begins to solidify at about

120°. It boils in a glass tube, containing a few fragments of glass, at 205°, and at a slightly higher temperature volatilises without residue. Soluble in less than its own weight of water, rectified spirit, or æther, and in four times its weight of chloroform. The aqueous solution is neutral, or but slightly acid to test paper (occasionally a trace of trichloracetic acid, which is not objectionable). A solution in chloroform, when agitated with sulphuric acid, does not impart any colour to the acid (freedom from chlorinated organic impurities). 100 grains of hydrate of chloral dissolved in an ounce of distilled water, and mixed with 30 grains of slacked lime, submitted to careful distillation, should yield not less than 70 grains of chloroform (proving the proper proportion of chloral).

Incompatibilities.—The caustic alkalies, including ammonia, decompose an aqueous solution of chloral hydrate with the liberation of chloroform at 60°. The carbonates and bicarbonates of potash and soda, and also borax, have the same effect at a higher temperature. A solution of 10 grains of chloral hydrate added to a solution of 30 grains of bicarbonate of soda in 10 fluid drachms of water at 90° evolves after half an hour the odour of chloroform. The sesquicarbonate of ammonia does not liberate chloroform.

Action.—The effects of chloral have been rather hastily assumed to be due to the liberation of chloroform in the blood by the decomposing action of its alkaline carbonates. Granting that such a decomposition occurs, we have the simultaneous liberation of formic acid. Observation has not given much support to this theory, and MM. Feltz and Ritter in particular find that the greater part of the chloral is exhaled unchanged from the lungs. Small quantities may be found in the urine, but no chloroform. MM. Musculus and de Mermé have isolated from the urine of patients, who were taking from 60 to 75 grains of chloral hydrate during the day, an acid which they provisionally term *urochloralic acid.* It has the following characters: very soluble in water and alcohol, decomposes the carbonates with effervescence, reduces alkaline solutions of copper, bismuth, and silver, decolorises sulphate of indigo, and turns the plane of polarisation to the left. Heated with potash it disengages an odour of caramel, and yields chlorine to the potash (*Acad. des Sciences*, 1875). The effects of chloral on the blood is, according to these observers, identical with that of chloroform; they state that after poisonous doses (in dogs) the blood-corpuscles are partly diffluent, giving the plasma a red colour; that on examination of a drop of blood the field of the microscope is rapidly covered with crystals of hæmoglobin; that this substance is readily detected by the spectroscope in the urine before death; and that the absorbent power of the blood for oxygen is greatly diminished (*Comptes Rendus*, 1874). In moderate doses chloral hydrate is a pure *hypnotic*, and the sleep is calm, easily interrupted, and refreshing. In larger doses it is *narcotic.* In proportion to the degree of narcotism there is *anæsthesia* of course. It acts primarily on the intellectual and motor centres, abolishing thought and motion; later on (after poisonous doses) narcotism and anæsthesia with depression of the reflex functions of the cranio spinal axis. The respiration becomes slow and feeble, and pulse dwindles to a thread, until both finally cease, and the individual dies tranquilly and flaccid, with dilated pupils. It would appear that chloral is open to the grave objection of nonuniformity of action, for it has been stated that a dose which on one or more occasions has produced only moderate effects, on another has induced fatal narcosis. Initial doses of 30 and 3 grains have proved fatal to a healthy adult and a child under three years of age respectively.

Uses.—A moderate dose of chloral speedily produces sleep, which continues for a period varying from three to six or eight hours. It may therefore be given in any case where opium is required, and in those where opium disagrees it is a most valuable substitute. As an anodyne, it is greatly inferior to opium, indeed where the pain is intense chloral exerts little or no hypnotic influence. As a relaxer of involuntary muscular fibre, it is superior to opium in spasmodic affections of the ducts, and it may be serviceably combined with opium to alleviate the pain attending the passage of gall stones or renal calculi. In some states of febrile excitement accompanied with a hard pulse, and in *delirium tremens*, it is very beneficial. It has also been recommended in tetanus. As an anæsthetic it is inferior to chloroform, and since we have to induce narcosis previously, it cannot safely be employed as such. The use of chloral is contraindicated in the same morbid conditions that render chloroform unsafe (see p. 341). A notable relaxation of the arterial walls occurs after a full dose. It is therefore unsuitable in typhus, especially if there be pulmonary complication as so often occurs. Chloral is unsuitable from intravenous injection, as it produces coagulation of the blood in the veins. It is equally unsuitable from subcutaneous use on account of the large quantity required, and the liability to inflammation of the tissue when concentrated solutions are used. The strongest solution that can be obtained (10 grains in 10 minims of water) produces a hard tumour of the integument, which is too slowly absorbed to produce sleep, and sloughing of the skin sometimes follows its use.

The intravenous injection of chloral hydrate (1 part in 4 of water) has been advocated for two opposite purposes—1, To coagulate the blood, and so obliterate varicose veins; and 2, to produce anæsthesia during long surgical operations. M. Oré is the advocate of this latter practice. He states that when the solution has been neutralised by bicarbonate of soda, it does not coagulate the blood. The injection of 80 grains was followed by complete anæsthesia for half an hour, during which an operation for ovariotomy was performed; and although the patient died within the hour, M. Oré considered the action of the drug a complete success (*Gaz. Méd. de Paris*, No. 52, p. 654). Such a procedure has not received the sanction of experience, but rather the contrary.

Dr Pavesi and other Italian physicians have called attention to the *antiseptic properties of chloral.* They state that meat and butter may be preserved for years in an atmosphere charged with chloral.

Dose.—5 to 30 grains. The initial dose for an adult should not exceed 10 grains.

1. **Syrupus Chloral,** *P.B.* *Syrup of Chloral.* 1 fluid drachm contains 10 grains.

Dissolve 80 grains of hydrate of chloral in half an ounce of water and add simple syrup to measure one fluid ounce.

This is the pleasantest mode of giving chloral.

Dose.—½ to 2 fluid drachms.

CROTON-CHLORAL HYDRATE. *Trichloro-Crotonic Aldehyd.*

$C_8H_3Cl_3O_22HO$ or $C_4H_3Cl_3O,H_2O$.

This substitution product of aldehyd was first obtained by Krämer and Pinner. It has been lately introduced by Dr Liebreich of Berlin as a remedy for facial neuralgia.

It is prepared by passing a stream of chlorine through acetic aldehyd for twenty-four hours, separating and purifying the oleaginous fluid (croton-chloral) which is formed, and converting it into hydrate.

The first change is the formation of croton-aldehyd, which is effected by the condensation of the acetic aldehyd and the separation of water, thus:—$2C_2H_4O = C_4H_6O + H_2O$. For a similar result, under different circumstances, see p. 460.

The croton-aldehyd then undergoes the same change as acetic aldehyd under the same circumstances (see p. 343), 3 atoms of hydrogen being converted into hydrochloric acid and removed, and replaced by 3 atoms of chlorine, thus:—$C_4H_6O + 6Cl = 3HCl + C_4H_3Cl_3O$, anhydrous croton-chloral.

Anhydrous croton-chloral is, like chloral, a dense, colourless, oily fluid; and further resembles chloral in odour, in its insolubility in water, and in the formation of a crystallisable *hydrate.*

Characters.—This latter occurs in minute, dry, white, flat rhombohedral prisms or tables of a micaceous lustre. In taste and odour they completely resemble chloral hydrate, slightly soluble in cold, but freely in hot water, very soluble in alcohol, moderately soluble in glycerin. Heated with caustic potash it is resolved into allyl-chloroform and formic acid:—$C_4H_3Cl_3O + KHO = C_3H_3Cl_3 + KCHO_2$, the formic acid uniting with the potassium (see p. 343). But allyl-chloroform is unstable, and breaks up into hydrochloric acid and dichlorallylene:—$C_3H_3Cl_3 = HCl + C_3H_2Cl_2$.

Action.—According to Liebreich, it has a specific influence over the sensitive branches of the fifth nerve, and has been given with benefit for the relief of facial neuralgia. It has no hypnotic power, and sometimes causes sickness. It is unfit for subcutaneous use, as it produces inflammation of the connective tissue.

Dose.—5 to 10 grains, dissolved in 1 or 1½ fluid drachm of glycerin, and mixed with peppermint or cinnamon water. Even when largely diluted, it has the nauseous bitter taste of a strong solution of Epsom salts, and a rich cowslip odour.

ALCOHOL AMYLICUM. *Potato Spirit.*

$C_{10}H_{12}O_2 = 88$ or $C_5H_{12}O = 88$.

Also called *oil of grain* and *fusel oil.* It constitutes the fifth of the alcohol series. It is a frequent impurity in malt spirit and brandies distilled from the fermentation of potatoes, and the marc of grapes; being less volatile than either alcohol or water, it accumulates in the still when spirits derived from the above sources are subjected to distillation, and it is obtained by continuing the process after these are driven off. On redistillation of the crude oil of grain, the first portions which come over are rejected; they consist of water, and æther and acids of the acetic series. Liebig states that the presence of a vegetable acid, or of hops in the fermenting liquor, greatly prevents the formation of fusel oil.

The amylic alcohol of the Pharmacopœia contains a small proportion of other spirituous substances.

Characters and Tests.—A colourless liquid, with a penetrating and oppressive odour, and a burning taste. When pure its sp. gr. is 0·818, and its boiling point 270°. Sparingly soluble in water, but miscible in all proportions with alcohol, æther, and the essential oils. Exposed to the air in contact with platinum black, it is slowly oxydised, yielding valerianic acid, just as alcohol yields acetic acid under the same influence.

Pharmaceutical Use.—The preparation of valerianate of soda.

1. **Valerianic Acid**: $HO,C_{10}H_9O_3 = 102$ or $HC_5H_9O_2 = 102$.

This acid is to amylic alcohol what acetic acid is to ordinary alcohol. Thus, under the influence of oxydising agents, amylic alcohol gradually absorbs 2 atoms of oxygen, and is converted with the elimination of a molecule of water into valerianic acid:—$C_5H_{12}O + O_2 = H_2O + C_5H_{10}O_2$.

The acid may be prepared from amylic alcohol by a variety of oxydising processes, of which the best is a mixture of bichromate of potash and sulphuric acid (see p. 166). It is also formed by the oxydation of oleic and other fatty acids, and occurs naturally in the root of *Valeriana officinalis* (which see) and the berries of *Viburnum Opulus.*

Characters.—A limpid, colourless oil, which remains liquid at 0°, sp. gr. 0·937, boils at 347°, and distils unchanged. It has a powerful odour, resembling that of valerian root, and a burning taste. It is sparingly soluble in water, but miscible with alcohol and æther in all proportions. Like acetic acid, it forms a definite hydrate with water, $HC_5H_9O_2,H_2O$. The valerianates are all soluble in water, excepting those of silver and mercury; those of the alkalies are deliquescent. They are readily recognised by the odour of valerianic acid when heated with sulphuric acid.

Pharmaceutical Use.—Employed extemporaneously in the production of valerianate of soda (see p. 166).

2. **Amylene, C_5H_{10}.**

Prepared by decomposing amyl-chloride by fusion with caustic potash. It has been substituted for chloroform in the production of anæsthesia; but there is more danger attending its use, and the odour is extremely disagreeable. It is a colourless, very mobile liquid, boiling at 102·°2, and has the odour of decaying cabbage.

AMYL NITRIS, *P.B.* *Nitrite of Amyl.*

$C_{10}H_{11}O,NO_3$ or $C_5H_{11}NO_2$.

Produced by the action of nitric or nitrous acid on amylic alcohol. A similar process to that employed for the preparation of nitrous æther may be adopted, as suggested by Tanner. Place 1 pint of pure amylic alcohol in a retort with 2 ounces of fine copper wire, and add gradually 2 fluid ounces of sulphuric acid, and then 2 fluid ounces of nitric acid diluted with an equal bulk of water. Apply the heat of a water bath until 150° are reached, and allow 2 fluid ounces to distil. After the temperature has fallen to 60°, add another 2 ounces of nitric acid, and proceed as before, adding other portions of nitric acid until the amylic alcohol is exhausted. Wash the mixed products with solution of soda, and rectify with fused carbonate of potash at a temperature not exceeding 205°.

The same reactions occur as in the production of nitrite of ethyl (see p. 335):—

$$C_5H_{12}O + HNO_3 + Cu + H_2SO_4 = CuSO_4 + 2H_2O + C_5H_{11}NO_2.$$

Characters and Tests.—An ætherial fluid of a yellowish colour and pine-apple odour and taste; sp. gr. 0·877; boiling point, 205°. Insoluble in water, miscible with rectified spirit in all proportions. Added drop by drop to fused caustic potash, valerianate of potash is formed. The vapour on exposure to the air is decomposed with the development of the odour of valerianic acid.

Action and Use.—It appears to exercise a paralysing influence on the sympathetic nervous system, the inhalation of 1 or 2 minims producing an immediate flushing of the face and a feeling of creeping warmth and distension of the vessels of the head. When a larger quantity is inhaled this effect is intensified, and is associated with greatly increased arterial tension and throbbing of the heart and arteries.

It has been recommended by Guthrie as a resuscitant in syncope, drowning, &c. Dr S. Weir Mitchell of Philadelphia used it in convulsions in 1871, and advocated its use as an anticonvellent in eclampsia. It has been given with success to relieve cardiac spasm in angina, gastralgia, especially of a spasmodic character, and facial neuralgia. It must be used with great caution.

Dose.—By inhalation, 2 to 5 minims, on a handkerchief; from 1 to 2 minims internally, in a little proof spirit.

ACETIC ACID. *Monohydrated Acetic Acid.*

$HO,C_4H_3O_3 = 60$ or $HC_2H_3O_2 = 60$.

100 parts contain 85 of acetic anhydride and 15 of water.

This, the proper acid derivative of alcohol, is readily formed by the oxydation of this body: aldehyd is first formed (see p. 337), and then acetic acid, thus: aldehyd, $C_2H_4O + O = C_2H_4O_2$. This slowly occurs when dilute alcohol is exposed to the air in contact with any readily decomposable vegetable matter or yeast. The change is immediately effected in pure alcohol by oxydising agents, such as platinum black, or a mixture of bichromate of potash and sulphuric acid.

Preparation.—Heat together 82 parts (1 molecule) of fused acetate of soda and 98 parts (2 molecules) of sulphuric acid. At 243° the acid distils. A little sulphurous acid is usually formed in the process; this is removed by rectification from potassic bichromate, which converts it into sulphuric acid; and it is thus retained in the retort.

Characters.—Above 62°·6, a colourless liquid, of a pungent but very agreeable penetrating odour and sharp acid taste; sp. gr. 1·063. At 62°·6 it becomes solid and crystallises in radiating plates. At 243° it boils and distils unchanged; the vapour is inflammable, the result of the combustion being carbonic anhydride and water. It is miscible in all proportions with water. When combined with an additional molecule of water ($HC_2H_3O_2 + H_2O$) its density is 1·079, having progressively increased to this point; then, on the further addition of water, the density decreases according to the usual law, and when diluted with an equal bulk of water, it has the same density as the monohydrated acid. Acetic acid blisters the skin, is miscible in all proportions with alcohol and æther, and dissolves the volatile and concrete volatile oils, such as camphor, kreasote, and several resins.

Acetic Anhydride, or *Anhydrous Acetic Acid,* $C_4H_3O_3$ or $C_4H_6O_3$, may be isolated by several processes. It is a colourless volatile liquid, with the pungent odour of acetic acid combined with that of hawthorn blossoms. Placed in water it sinks as oily drops, which slowly dissolve with the evolution of heat, forming the ordinary dilute acid.

The following varieties of acetic acid require description:—

1. Acidum aceticum glaciale,	containing	84	per cent. of	anhydrous acid.
2. Acidum aceticum,	”	28	”	”
3. Acidum aceticum dilutum,	”	3·6	”	”
4. Acetum,	”	4·6	”	”

1. **Acidum Aceticum glaciale,** *P.B. Glacial Acetic Acid.*

Concentrated acetic acid, containing 84 per cent. at least of anhydrous acid.

Characters and Tests.—It crystallises when cooled to 34°, and remains so until the temperature rises above 48°; sp. gr. 1·065 to

1·066, and this is increased by adding 10 per cent. of water (see above). At the mean temperature of the air it is a colourless liquid, having the characters of the monohydrated acid. 60 grains mixed with a fluid ounce of water require for neutralisation at least 990 gr. measures of the volumetric solution of soda. If a fluid drachm be mixed with half an ounce of water and half a drachm of pure hydrochloric acid, and put into a small flask with a few pieces of granulated zinc, and a slip of bibulous paper wetted with solution of subacetate of lead be suspended in the flask for 5 minutes over the escaping gas, the paper will not become discoloured (absence of sulphurous acid—see p. 59).

Action and Uses.—Owing to its action on the albuminous and gelatinous tissues, strong acetic acid is *caustic*, vesicant, and destructive of minute living organisms. As an immediate *vesicant* or *rubefacient*, it may be applied to the skin by means of a piece of blotting paper. It is a very useful caustic in the early stage of epithelioma; it should be rubbed into the induration with a stiff brush, made by chewing the end of a deal stick, such as lucifer match, until the cuticle or mucous membrane becomes white. As an effectual remedy against vegetable parasites, such as ring-worm (dermmycocis circinata) and the like, it should be applied in the same way. It may be employed to destroy the indurated edges of chronic ulcers. As a stimulant and antiseptic, it may be carefully applied to the fauces in scarlatina when there is sloughy ulceration and fœtor. In milder cases, diluted with 10 parts of water, it is beneficial as a gargle. Internally, acetic acid has the general acidifying action of an acid, and tends, I believe, to the accumulation of uric acid in the body. It may be given as a mineral acid in phosphaturia and cystitis. Diluted with water it is refrigerant in fever; but it is superseded by lemon or lime juice. As an enema (equal parts of vinegar and water) it may be used to expel the ascaris vermicularis. Externally a lotion of acetic acid is a grateful refrigerant in headache, phrenitis, or to bruised parts.

Pharmaceutical Uses.—In the preparation of Acetum cantharidis and Mistura kreasoti.

2. **Acidum Aceticum.** *P.B.* *Acetic Acid.*

Prepared from wood by destructive distillation, and subsequent purification. It contains 33 per cent. of the monohydrate, corresponding to 28 parts of acetic anhydride. It corresponds in strength with commercial acetic acid. The sources of acetic acid are two—1. The acetous fermentation of alcohol; and, 2. The destructive distillation of hard wood. The former furnishes the varieties of vinegar; the latter, the acid under consideration.

It may be inferred from the following passage in Pliny that pyroligneous acid was known to the Egyptians:—Pine wood heated in a furnace gives it out, "Sudore, aquæ modo fluit canali: hoc in Syria *cedrum* vocatur, ac tanta est vis, ut in Ægypto, corpora hominum defunctorum, eo perfusa, serventur."

Preparation.—At the present day the hard wood of the oak, beech, ash, birch, &c., is heated to low redness in iron retorts. The product is a dark brown, tarry, acid liquid, containing from 1½ to 3½ per cent. of acetic acid, and several volatile products, the most important of which are tar, wood spirit, acetate of methyl, and acetone. Much combustible gas (chiefly hydrogen and carbonic oxyde) is formed, and this is utilised in heating the retorts. Charcoal of capital quality remains in the retorts. The crude acid liquid is decanted from the tar and distilled; wood spirit (see p. 336) is volatilised and collected first, and then the acetic acid. This, however, is still contaminated with tarry matters, and to remove these the acid is neutralised with milk of lime or carbonate of soda and allowed to stand, when the tarry matter rises and is separated; the fluid is then evaporated to dryness, and the residue roasted at about 500°, to expel the residual tarry matter. It is then dissolved, separated from carbonaceous matters, crystallised, and distilled with sulphuric acid (if acetate of soda) or hydrochloric acid (if acetate of lime). The distillation should be effected in glass or earthenware vessels.

Characters and Tests.—A colourless liquid, having a strong acid reaction and pungent odour; sp. gr. 1·044. 182 grains require for neutralisation 1000 grain measures of the volumetric solution of soda, indicating thereby that it contains 1 molecule (51 grains) of anhydrous acetic acid. The tests of its purity are those given under glacial acetic acid.

Pharmaceutical Uses.—In the preparation of the following:—Acidum aceticum dilutum, Aceticum cantharidis, Oxymel, Oxymel scillæ, Syrupus scillæ, Mistura kreasoti, Extractum colchici aceticum, Linimentum terebinthinæ aceticum, Liquor epispasticus.

3. **Acidum Aceticum dilutum,** *P.B.* *Dilute Acetic Acid.*

A mixture of 1 volume of acetic acid (No. 2.) and 7 volumes of water. The sp. gr. is 1·006. 440 grains (1 fluid ounce) require for neutralisation 313 gr. measures of the volumetric solution of soda, corresponding to 3·63 per cent. of anhydrous acid.

Action and Uses.—(See Acetic acid).

Dose.—1 to 2 fluid drachms. As a lotion or enema, it may be used diluted with 2 or 3 parts of water.

Pharmaceutical Uses.—Acetum scillæ, Liquor morphiæ acetatis.

4. **Acetum,** *P.B.* *Vinegar.*

An acid liquor prepared from malt and unmalted grain by the acetous fermentation.

Since vinegar is produced when weak spiritous liquors are simply exposed to a warm air, it has been known from the earliest times. The conversion of the alcohol in this case is effected by organic matter, generally sugar, which is present in the solution, and which serves as a ferment. The change is rapidly effected by yeast (see p. 364), and the process is termed the *acetous fermentation,* a molecule of alcohol being converted into one each of water and acetic acid, $C_2H_6O + O_2 = H_2O + C_2H_4O_2$. The acetous fermentation is but a continuation of the alcoholic. A good vinegar may be made by dissolving 1¼ pound of sugar in 1 gallon of water, adding a quarter of a pint of yeast, and keeping the mixture for three days between 77° and 86°, then adding 1 ounce of bruised raisins, and after ripening it by further exposure in a cask, bottling it. The yeast first converts the sugar into alcohol, and then resolves it into acetic acid and water.

Preparation.—Allow an infusion of malt to trickle slowly over wood-shavings arranged in deep tubs on porous wooden diaphragms, so as to expose the surface of the liquid freely to the air, which is also admitted from below by suitable apertures; vinegar slowly collects and flows away. When the process is fairly established, a gelatinous fungus, "*mother of vinegar*," forms upon the surface of the shavings, and acts as an oxydising medium. In order to prevent the further development of this plant in the former product, $\frac{1}{1000}$ part of its weight of sulphuric acid is added to the vinegar.

Characters and Tests.—A liquid of a brown colour and the agreeable odour of acetic æther; sp. gr. 1·017 to 1·019; 445·4 grains (1 fluid ounce) require at least 402 gr. measures of the volumetric solution of soda for neutralisation, corresponding to 4·6 per cent. of anhydrous acetic acid. If 10 minims of the solution of chloride of barium be added to 1 fluid ounce of the vinegar, and the precipitate, if any, be separated by filtration, a further addition of the test will give no precipitate (showing the presence of no more sulphuric acid than the $\frac{1}{1000}$ of its weight, which is allowed by law); sulphuretted hydrogen causes no change of colour (absence of metallic impurity, especially copper, which is easily derived by carelessly allowing contact with copper vessels).

Dose.—1 to 2 fluid drachms.

Pharmaceutical Use.—In the preparation of Emplastrum cerati saponis.

5. Acetum Gallicum. *French* or *Wine Vinegar.*

As its name implies, is prepared from wine. Casks capable of holding 100 gallons, partially open at the upper part to allow excess of air, are arranged in rows in a shed at a temperature of 75° to 85°. A small quantity of boiling vinegar is placed in each cask, and every eight or ten days a few gallons of wine are added until the casks are two-thirds full. After a fortnight the acetification is complete; a few gallons of the vinegar are then drawn off from each cask and the same quantity of wine added, and so the process proceeds continuously. A quantity of gelatinous conferva (mother of vinegar) forms in the old casks, in which the conversion goes on most rapidly, the vegetable acting like platinum black in bringing condensed or nascent oxygen in contact with the dilute alcohol. Wine vinegar may be white or red, according as red or white wine is used.

Acetates.—These salts are decomposed by the stronger acids, and are distinguished by the evolution of the pungent odour of acetic acid when heated with sulphuric acid. Heated with lime they yield *acetone* (C_3H_6O), a colourless inflammable liquid of an agreeable ætherial odour and pungent taste. When distilled with potassic hydrate they yield marsh gas (see p. 99). Cold solutions give with mercurous nitrate a precipitate of mercurous acetate. With the per-salts of iron the soluble acetates form deep reddish-brown solutions (see p. 215).

GLYCERIN: $C_6H_8O_6$ or $C_3H_8O_3$.

A sweet principle separated from all fats and oil, except spermaceti and wax, by saponification.

Preparation.—By the saponification of olive oil by oxyde of lead, as described under Lead plaster (p. 242).

Characters.—A colourless fluid, sweet, odourless, viscid, and of the consistence of thick syrup; of sp. gr. 1·28; solidifying to a crystalline mass like loaf sugar at $-4°$; slightly volatile, and vapourisable without decomposition in a current of steam between 500° and 600°, but when heated in the air evolving most intensely irritating fumes of *acrolein* (C_3H_4O). When strongly heated it burns with a luminous flame. It is miscible in all proportions with water and alcohol, and absorbs the former when exposed to a damp air; it is sparingly soluble in æther. It has a greater solvent power than water over many compounds, both inorganic and organic, thus it dissolves baryta, lime, and strontia freely, and the solutions are not precipitated by carbonic acid. It is also used as a solvent for arsenious acid, some of the alkaloids of opium, which are but sparingly soluble in alcohol and in water, for croton-chloral-hydrate, &c. Heated with caustic potash, it is resolved into a mixture of acetate and formiate of potash with the elimination of water and hydrogen: $C_3H_8O_3 + 2KHO = KC_2H_3O_2 + KCHO_2 + H_2O + 4H$.

Nitric acid resolves it into carbonic and oxalic acid, but when dropped into a mixture of equal measures of nitric and sulphuric acid 3 atoms of hydrogen are displaced by 3 molecules of peroxyde of nitrogen to form the frightfully explosive body nitro-glycerin: $C_3H_5(NO_2)_3O_3$.

Glycerinum, *P.B.* *Glycerin.*

This is the substance above described, containing a small percentage of water; sp. gr. 1·25.

Action and Uses.—Glycerin is the type of an emollient; excepting that it absorbs a little water it is unchanged in the air, and when applied to a dry harsh surface preserves it moist and soft. Hence it is a most useful application to a dry, cracked skin. In its concentrated state it is, however, rather heating and irritant; it should therefore be used diluted with an equal quantity of water. It has been given internally as a substitute for cod-liver oil where the stomach will not bear this food, but medicinal properties are inappreciable, and its dietetic value has not been satisfactorily ascertained.

Dose.—1 to 2 drachms.

Pharmaceutical Uses.—As a solvent it is employed in the preparation of Glycerinum acidi carbolici, G. acidi gallici, G. acidi tanici, G. amyli, and G. boracis. It is also an ingredient of Linimentum potasii iodidi cum sapone.

BENZOL. *Benzine* or *Phene.* $C_{12}H_6$ or $\mathbf{C_6H_6}$.

A volatile liquid, giving off at 177·8 an inflammable vapour, obtained from coal tar. It is the first of the Phenic series. It obtains its first and second names from benzoic acid, which when distilled with excess of lime yields a third of its weight of benzol. Mansfield obtained it from the most volatile portions of coal naphtha, 2 gallons of which will yield 1 pint of pure benzol.

Characters.—A limpid, colourless liquid, of sp. gr. 0·85, and a pleasant balsamic odour; at 32° it solidifies to a mass of crystals. It is insoluble in water but freely soluble in alcohol, æther, wood spirit, oil of turpentine, and acetone. It readily dissolves caoutchouc, gutta-percha, wax, and the fixed oils. The resins are soluble with difficulty in benzol. It furnishes substitution compounds with nitroxyl, the most interesting of which is *nitrobenzol* ($\mathbf{C_6H_5NO_2}$) or *essence of mirbane*, a very sweet yellowish oil, having the odour of oil of bitter almonds, for which it is used as a substitute in scenting soap and perfumery.

Action and Uses.—Narcotic and anæsthetic, but it is not used internally. It is a valuable solvent for fatty substances, and as such is extremely useful for removing grease and spots from silks or woollen fabrics.

ACIDUM CARBOLICUM, *P.B.* *Carbolic Acid.*

$HO,C_{12}H_5O$ or $\mathbf{HC_6H_5O}$.

Phenic Acid. Oxybenzene. Phenyl Hydrate. Phenol.

An acid obtained from coal tar by fractional distillation, and subsequent purification. The heavier oils, which boil between 300° and 450°, are neutralised with alkali, and the compound so produced separated and decomposed by mineral acid. The oily liquid separates, which is purified by rectification. Phenic acid is closely related to salicylic acid, which is so frequently met with in the vegetable kingdom (see p. 356). It is one of the products of the distillation of benzoin (see Benzoin) and of the resin of the *Xanthorrhœa hastilis;* and it has been also found in the urine of herbivorous animals, of which hippuric acid, so closely related to the benzoic series of compounds, is a constant constituent.

Characters and Tests.—In colourless acicular crystals, which become an oily liquid at 95°, of sp. gr. 1·065 and boiling point 370°, having an odour and taste like kreasote, which it also resembles in many of its characters and properties. The crystals readily absorb moisture on exposure to the air, and are thus liquefied. It is soluble in about 30 parts of water, freely soluble in glycerin, and is miscible with alcohol, æther, and acetic acid in all proportions. It precipitates collodion and albumin, and does not redden blue litmus. A slip of deal dipped into it and afterwards into hydrochloric acid, and then allowed to dry in the air, acquires a greenish-blue colour. It does not affect the plane of polarisation of a ray of polarised light (thus distinguished from kreasote).

Phenic acid combines with potash to form a crystalline compound. Heated with ammonia in a sealed tube it is converted into water and *aniline:* $C_6H_6O + H_3N = H_2O + C_6H_5,H_2N$.

Sulphuric acid dissolves phenic acid without change of colour, combining with it to form a compound monobasic acid called *sulphophenic acid* ($HC_6H_5SO_4$), which forms permanent odourless, crystallisable *sulphocarbolates* or *sulphophenates*, with soda, zinc, and other bases. Nitric acid decomposes phenic acid with violence, displacing hydrogen and substituting NO_2 in its place, and, according to the degree of concentration, forming *trinitrophenic* or *carbazotic acid* ($HC_6H_2(NO_2)_3O$) *dinitrophenic acid* ($HC_6H_3(NO_2)_2O$), and *nitrophenic acid* ($HC_6H_4NO_2O$), crystalline acids, all forming crystallisable salts closely resembling each other. Chlorine, bromine, and iodine in like manner displace hydrogen, and form a great number of substitution products, formed as the above nitroxyl series, on the type of phenic acid; they are all monobasic, and form crystalline salts. The remarkable decomposition effected by carbonic anhydride is considered below.

Action and Uses.—Carbolic acid is absorbed into the blood, and when taken in large quantities is eliminated unchanged by the kidneys. In a case where a nearly fatal dose was taken, 26¾ ounces of urine were passed between the fifth and twelfth hours after the acid was taken; the urine was acid, of sp. gr. 1·016, free from blood, had the appearance of milk and water to which a few drops of ink had been added, and a powerful odour of carbolic acid or kreasote, became blue-black on exposure to the air, and 4 ounces of it yielded nearly 3 grains of impure carbolic acid (Dr Stephenson, *Guy's Hosp. Rep.* 1875, p. 150). The natural odour of urine has been supposed by some to be due to phenic acid, and it is certainly intensified by its use, and furnishes a notable quantity of *indican* (see Indigo). Large doses of carbolic acid speedily produce insensibility, passing into deep coma and failure of the respiro-cardiac functions. Locally it is a powerful styptic, producing coagulation of the mucous membrane and arrest of its function, and destroying the minute organisms on which the fermentative and putrefactive actions depend. A saturated aqueous solution is irritant, highly antiseptic and disinfectant, and as such it is thoroughly efficacious in removing the fœtor of sloughy or ill-conditioned wounds and discharges. It is invaluable as an intra-uterine injection after labour, or operations where from decomposing blood clot or retained secretions the discharges are offensive. As a disinfectant in glanders, smallpox, and infectious diseases generally, it may be freely used in the form of lotion; and cloths wrung out of a saturated solution should be hung in the sick room and its approaches, and the pan which receives the excreta should be constantly charged with the same. As a parasiticide in fungous skin diseases it may be used in the form of lotion combined with the use of carbolic acid soap.

The sulphocarbolates of soda and zinc, the former for internal and the latter for external use, have been suggested, and to some extent employed, instead of the crude acid, but their efficacy is not very apparent.

Internally, carbolic acid may be given instead of kreasote, which, however, is preferable on account of its pleasanter and more familiar taste. It has been advocated in diabetes, on the theory that this disease is generated by fermentative action. After fair trial in a few cases I discontinued its use, finding that it had no influence on the disease.

Dose.—1 to 3 grains in a suitable tincture. As a lotion, disinfectant, and vaginal injection, an aqueous solution (1 part in 50) may be used. As an intra-uterine wash, a solution of half this strength is sufficient. As a disinfectant dressing, 1 drachm of the glycerin solution with 7 drachms of simple ointment.

1. **Glycerinum Acidi Carbolici,** *P.B.* *Glycerin of Carbolic Acid.*

Composed of 1 ounce of *carbolic acid* and 4 fluid ounces of *glycerin*, rubbed together until the acid is dissolved.

Use.—Except as a styptic this is too strong an application, but it affords a ready means of forming oleaginous and aqueous solutions of the acid.

SALICYLIC ACID: $HO,C_{14}H_5O_5 = 138$ or $HC_7H_5O_3 = 138$.

This interesting body, so long associated with the willow, the meadow-sweet, and the winter-green (*Gaultheria procumbens*), is now largely prepared from phenic acid. Dry carbonic anhydride is passed through the dry powder of phenol-sodium between 212° and 482°; amongst other compounds, salicylate of sodium is formed. This is dissolved in water and decomposed by hydrochloric acid, which unites with the base and sets free the acid in the form of small crystals. These are washed and recrystallised from a hot solution and dried (Kolbe).

Characters.—A soft light powder, as bulky as quinine, of a delicate cream colour from the presence of a little colouring matter, composed of minute acicular crystals. It is odourless, but has a sweet, and afterwards a dry taste, with an impression of acridity: very soluble in hot water, and in about 400 parts at 60°. Salts, such as phosphate of soda, greatly increase its solubility, 3 parts of the salt rendering 1 part of the acid soluble in 50 parts of water. It is more freely soluble in alcohol and æther, melts at 316°, and sublimes unchanged. Distilled with excess of lime, it is resolved into carbonic and phenic acids, $HC_7H_5O_3 + CaO = CaCO_3 + HC_6H_5O$.

Action and Uses.—A little placed in contact with the moist mucous surface speedily converts it into a dry, white, shrivelled membrane, attended by a pleasant feeling of warmth. It is indeed destitute of direct irritant properties. After ingestion it is speedily eliminated by the kidneys. Like phenic acid and kreasote, it arrests fermentation and putrefaction; but its power in these respects is inferior to these substances. It, however, possesses the great advantage of being free from taste and odour, which renders it suitable for many purposes for which other antiseptics would be objectionable.

KREASOTUM, *P.B.* *Kreasote* (*κρέας, flesh; σώζω, to preserve*).

A mixture of volatile oils obtained by the distillation of wood tar.

According to Schorlemmer it is composed of *phenic acid*, C_6H_6O; *kresol*, C_7H_8O; *phlorol*, $C_8H_{10}O$; *guiacol*, $C_7H_8O_2$; and chiefly *kreasol*, $C_8H_{10}O_2$. It is contained in the heavier oil obtained by the distillation of wood tar; the lighter being separated by water on which it floats. It is deprived of acetic acid by solution of caustic potash, which also dissolves it and separates it from other hydrocarbons. The alkaline solution is boiled in an open basin to oxydise some impurities; the kreasote is then liberated by a slight excess of dilute sulphuric acid, and several times rectified.

Characters and Tests.—A liquid, colourless or with a yellowish tinge; sp. gr. 1·071, boiling at 400°, and having a strong empyreumatic odour, and burning, smoky taste. Sparingly soluble in water, but freely in alcohol, æther, acetic acid, and benzol. It coagulates albumen, but gives no precipitate with collodion. A slip of deal dipped into it and afterwards into hydrochloric acid, acquires on exposure to the air for a short time a greenish-blue colour. Dropped on white filtering paper and exposed to 212° of heat, it leaves no translucent stain; it turns the plane of polarisation of a ray of polarised light to the right. It is insoluble in glycerin, and is not solidified by the cold produced by a mixture of hydrochloric acid and sulphate of soda.

The above mentioned tests are intended to distinguish it from or to indicate admixture with carbolic acid, which has been freely substituted for kreasote.

Action and Uses.—Those of carbolic acid. The urine, in like manner, acquires the odour of the substance and a dark colour, and contains *indican.* In large doses it is an irritant poison, causing vomiting, sometimes strangury, vertigo, and coma. 2 fluid drachms have proved fatal. If it can be brought in contact with the painful part, it is a valuable remedy in toothache. It is chiefly employed to prevent fermentative decomposition of the food and the development of sarcinæ in the stomach, or to correct an offensive condition of the secretions which is often associated with simple enteritis and diarrhœa. As a styptic it is given in hæmatemesis. It is applied as an escharotic to unhealthy granulations, or to bleeding tumours of a fungoid character. In solution it may be used as carbolic acid. It is used to preserve salted or dried meats.

1. **Mistura Kreasoti**, *P.B.* *Kreasote Mixture.*

Contains 1 minim in a fluid ounce.

Preparation.—Mix 16 minims each of *kreasote* and *glacial acetic acid;* add gradually 15 ounces of *water*, and lastly, ½ fluid drachm of *spirit of juniper* and 1 fluid ounce of *syrup.*

Dose.—1 to 2 fluid ounces.

2. **Vapor Kreasoti**, *P.B.* *Inhalation of Kreasote.*

Mix 12 minims of *kreasote* and 8 ounces of *boiling water* in an apparatus so arranged that air may be drawn through the liquid in the process of inhalation.

Use.—In putrid sore throat, diphtheria, and gangrene of the lung.

3. **Unguentum Kreasoti**, *P.B.* *Kreasote Ointment.*

A mixture of 1 fluid drachm of *kreasote* and 1 ounce of *lard.*

Use.—A stimulant antiseptic dressing to wounds, and a suitable application in skin diseases of fungous or syphilitic origin.

PIX LIQUIDA, *P.B.* *Wood Tar.*

A bituminous liquid obtained from the wood of *Pinus sylvestris* (see p. 405) and other pines by destructive distillation.

The decomposition commences at about 284°; both gases and liquids are evolved. The most abundant of the gaseous products are carbonic anhydride, carbonic oxyde, and hydrogen. Of the liquids, acetic acid, wood spirit, methyl-acetate, acetone and water, are soluble in water; the remainder are oily hydrocarbons, which collectively constitute *wood tar.*

The several varieties of pine-wood tar are Stockholm, Archangel, and American. The Swedish and Russian are preferred to American.

It is prepared at Bothnia by a process identical with that of charcoal-burning in England, with a special provision for the collection of the tar which exudes from the smouldering wood and by which it flows into conical cast-iron receptacles at the base of the excavation on the bank-side where the piles are erected. From these receptacles the tar flows along a pipe which opens on the bank and delivers the tar into barrels placed in succession beneath its orifice. As fast as the barrels are filled they are bunged, and are then ready for exportation. The wood furnishes between 7 and 8 per cent. of tar.

Characters.—Thick, viscid, brownish-black, of a well-known peculiar aromatic odour; water agitated with it acquires a pale-brown colour, sharp empyreumatic odour and taste, and an acid reaction. Subjected to distillation, oil of turpentine, kreasote, and other volatile hydrocarbons, pass over, and a black resin, commonly known as pitch, remains.

Action and Uses.—Tar is stimulant, diuretic, and diaphoretic. The aqueous solution possesses the antiseptic properties of a solution of kreasote or phenic acid, and may be used for the same purposes. Externally tar, in the form of tar-water or ointment, has long maintained a reputation in the treatment of chronic skin diseases and foul indolent ulcerations.

1. **Unguentum Picis Liquidæ,** *P.B. Tar Ointment.*

Preparation.—Melt 2 ounces of *yellow wax* with a gentle heat; add 5 ounces of *tar*, and stir the mixture briskly while it cools.

2. **Pix Nigra.** *Common Pitch.*

The residue of the distillation of wood-tar. It is chiefly altered resin (see p. 408), and is soluble in alcohol and solutions of the alkalies and their carbonates.

Uses.—It is given as a stimulant in doses of 10 to 40 grains, in the form of pill, but is rarely used internally. As a fumigation it is an admirable disinfectant; a red-hot poker should be inserted into a mass of the pitch contained in an iron pot, and the rooms and passages of the house filled with the fumes.

MINERAL TAR. *Petroleum* (*petri oleum*) or *Rock Oil.*

A black oil-like exudation from rocks. There are two kinds, natural and artificial. The latter is gas tar, produced by the distillation of coal; the former is the Barbadoes tar of commerce.

Petroleum is very extensively diffused, and in some places lavishly produced. It varies in consistency from solid asphalte to thin naphtha. In Barbadoes, Trinidad, Shropshire, &c., it is found floating on springs of water. It occurs in many parts of Europe, and abundantly in North America, where, in the vicinity of Toronto, in Pennsylvania, numerous springs and wells have been lately discovered. In Asia, it is found at Baku on the shores of the Caspian; and in Burmah on the banks of the Irawaddy, it is readily obtained by digging in the sand in hot weather. Ranan-goong or Earth-oil Creek has furnished 400,000 hogsheads annually.

Characters and Composition.—Petroleum has the consistency of treacle, a reddish-brown or black colour, a slight pitchy taste and odour; floats on water, in which it is wholly insoluble; burns with a dense sooty flame; is soluble in æther and the volatile and fixed oils. Exposed to the air it is converted into *bitumen* or *asphalte.* It is almost entirely composed of volatile constituents, so that when distilled in a current of superheated steam, only 4 per cent. of solid matter remains. 11 per cent. distils below 212°, and about 11 per cent. more is *paraffin*, a hard crystalline, tasteless, and odourless substance like spermaceti. *Naphtha* is the chief liquid product of the distillation of petroleum. It is a nearly colourless, limpid liquid, of a strong petroleum odour; sp. gr. about 0·8. It burns like alcohol, and being simply composed of hydrocarbon and without any tendency to oxydation, is employed for the preservation of potassium, sodium, &c. It is soluble in 8 parts of alcohol, and in æther and the volatile oils in all proportions. By the aid of heat it dissolves sulphur and phosphorus freely. It is an excellent solvent for caoutchouc, resins, and fatty bodies generally, and is used instead of spirit for burning in lamps, singeing horses, &c.

Action and Uses.—Stimulant and antiseptic. Dissolved in olive oil it may be used externally as a rubefacient in rheumatism and chronic skin diseases, such as psoriasis and ichthyosis. It has been recommended as a vermifuge. Naphtha is sometimes used internally as an antiseptic, but it is neither so efficacious nor so pleasant a remedy as kreasote.

SUCCINUM. *Amber.*

A fossil product, derived doubtless from coniferous trees which form submerged forests on the shores upon which it is found.

Amber (ἤλεκτρον), and its property of attracting light bodies, was known to the Greeks and also to the Arabs, being their *kah-roba* (grass-attracter). This country is chiefly supplied from the Baltic, the amber being cast ashore between Königsberg and Memel. In India it is obtained both in Kutch and Assam. It occurs in irregular pieces, often inclosing insects and parts of plants; is yellowish and transparent, resembling bright clear resin; sp. gr. about that of water. It is hard but brittle, and breaks with a conchoidal fracture, and is devoid of taste and smell. About $\frac{1}{8}$th is soluble in alcohol, and $\frac{1}{10}$th in æther. When heated in closed vessels, it melts and gives off *succinic acid* ($H_2C_4H_4O_4$), a yellow crystalline sublimate, and "oil of amber," a thin yellowish empyreumatic oil, having nearly the same composition as oil of turpentine. The succinic acid may be purified by solution in alcohol and recrystallisation. It forms large regular rhombic plates. It is related to butyric acid, which, by oxydation, is converted into succinic.

Action and Uses.—Succinic acid is supposed to be expectorant. The oil is stimulant and antispasmodic, in doses of 5 to 10 minims. Applied externally, it is stimulant and rubefacient.

ALGÆ, *Juss.* Sea-Weeds.

Cellular plants living in water or in wet places, and propagated by zoospores, coloured spores, or tetraspores.

CHONDRUS CRISPUS, *Grev.* Carrageen or Irish Sea-Weed.

Common on the rocky sea shores of the northern parts of Europe and America.

Characters.—Thallus dichotomously cleft with cuneate segments, from 2 to 12 inches long, purple-brown or greenish. *Sori* elliptical, imbedded in the substance of the thallus, concave on one side.

It is collected on the west coast of Ireland, and bleached and dried by exposure to the sun; thus prepared, it is cartilaginous, white, and slightly translucent. It swells up in cold water, acquires its original bulk, and odour of sea-weed. Boiled with 20 times its weight in water, it forms on cooling a tasteless jelly, which gives the reaction of mucilage. Carrageen does not contain starch, but its tissues can be stained blue by iodine. It contains a small proportion of bromides and iodides, and yields about 15 per cent. of ash.

Action and Uses.—It is slightly alterative and nutritive, and demulcent. Its nutritive value is very low. It is used for jellies and soups instead of gelatin, and as *bandoline* for keeping the hair in form. A decoction of ½ an ounce (previously soaked in water) in a quart of milk sweetened and flavoured; or a jelly made by the addition of more carrageen, is a suitable form for invalids.

PLOCARIA CANDIDA, *Nees.* **Starchy Fucus or Ceylon Sea-Weed.**

Characters.—Thallus in cylindrical ramifications, smooth, filiform, and acute. *Fructification* in hemispherical sessile *coccidia*, containing oblong spores on a central axis, and two oblong tetraspores imbedded in the surface.

This is more nutritive than the former, 100 parts yielding 15 of starch, 54·5 of vegetable jelly, 4 of mucilage, 18 of cellulose, and 7·5 of inorganic salts (*O'Shaughnessy.*) 1 part boiled with 50 of water furnishes a tasteless jelly. The Chinese use it as a sweetmeat.

OTHER ALGÆ. **Fucus Vesiculosus. Sea-Wrack or Bladder Wrack.**

This, like the others mentioned at p. 75, contains a notable quantity of iodine, and is a chief source of kelp. It is used as a friction and internal remedy for goïtre, enlarged joints, and obesity.

Species of **Porphyria** and **Ulva** yield *Laver*, which is used as food in Lapland.

LICHENES, *Juss.* Lichens.

They spread upon the earth, or on rocks, or on the bark of trees, sometimes burrowing into their substance. Some are mucilaginous and nutritious, others bitter and astringent, and a few remarkable for yielding colouring matter.

CETRARIA ISLANDICA, *Acharius.* **Iceland Moss.**

Characters.—Thallus erect, 2 to 4 inches high, dry, leathery, smooth; foliaceous and laciniated; lobes irregularly divided, channeled, and fringed at the margins. Fructification flat brown plates (*apothecia*) on the thickened margins of the thallus. *Habitat,* dry mountainous regions.—*Woodv. Med. Bot.* pl. 205; *Steph. and Church,* pl. 69; *Nees von E.* pl. 10.

Cetraria, *P.B.* *Iceland Moss.*

The entire plant; native of the north of Europe.

Characters and Constituents.—Foliacious, lobed, crisp, cartilaginous, brownish-white, paler beneath; bitter and mucilaginous. A strong decoction gelatinises on cooling.

It is composed of 70 per cent. of lichenin or lichen starch, $C_{10}H_{20}O_{10}$, closely related to cellulin and ordinary starch. Like the former, it is soluble in ammoniacal solution of oxyde of copper, and like the latter, it is coloured blue by iodine. Unlike gum, and jelly of chondrus, it furnishes but a trace of mucic acid when boiled with strong nitric acid; but like these and all other varieties of cellulin and starch, it is converted into sugar by boiling with dilute acids. Its solution is precipitated by alcohol. Besides this variety of mucilage, the lichen contains 3 per cent. of *cetraric acid* ($C_{18}H_{16}O_8$), 1 per cent. of *licheno-stearic acid* ($C_{14}H_{34}O_3$), a crystalline fat, and a little *fumaric acid* and *sugar.* Cetraric acid is a bitter, colourless, crystalline substance, soluble in alcohol and æther, but feebly soluble in water. It forms with the alkalies soluble, bitter yellow salts, which have been proposed as a substitute for quinine.

Cold water dissolves only a small portion of the lichenin, and the lichen is easily freed from the bitter principle (cetraric acid) by macerating it in 24 times its weight of a solution of 1 part of alkaline carbonate in 375 parts of water. Prolonged maceration in water is, however, sufficient.

Action and Uses.—The inhabitants of Iceland and Lapland use it as an article of diet, either made into bread or boiled with milk. It is demulcent, and when not deprived of its bitter principle, tonic; and is adapted for cases such as advanced phthisis, where stronger remedies are unsuitable, in the form of the following:—

Decoctum Cetrariæ, *P.B.* *Decoction of Iceland Moss.*

Preparation.—Wash 1 ounce of *Iceland moss* in cold water to remove impurities, boil it with 1 pint of *water* for ten minutes in a covered vessel, and strain while hot; wash the remainder with enough water to make the decoction measure 1 pint.

Dose.—1 to 4 ounces.

ROCCELLA, *Ach.* SPECIES VARIÆ. Litmus Lichens.

These are rigid suffruticose lichens, growing on the maritime rocks of Madeira, the Azores, Canary, and Cape de Verde islands, and Madagascar and Angola.

R. tinctoria and *R. fuciformis* are the species which chiefly supply the colouring matter. The thallus of the former is branched; the branches are more or less erect, cylindrical, slightly waved, and tapering to a fine point; they are beset with powdery wart-like *soredia;* the *apothecia* are pruinose and bordered. The thallus of the latter is flat.

Preparation.—The lichen is ground and moistened with a solution containing the *carbonates of ammonium* and *potassium*, and exposed to the air for a few hours. It is then digested in a hot solution of ammonia for a few hours longer, and the clear fluid is then drawn off and exposed in deep jars to the air for a few weeks, the solution is then concentrated by evaporation until the blue colour is intense, it is then made into a paste with chalk or plaster of Paris, and formed into little cakes.

Rocella and the genera mentioned below as furnishing cudbear and archil, contain from 7 to 12 per cent. of various colourless acids, of which the chief are *erythric* ($C_{20}H_{22}O_{10}$), *evernic* ($C_{17}H_{16}O_7$), and *orsellic* ($C_8H_8O_4$). These are decomposed by alkalies into other acids and a neutral substance, *orcin* ($C_7H_8O_2$), which, under the influence of ammonia and oxygen, is converted into the blue colouring matter called *orcein* ($C_7H_7NO_3$), which is the essential constituent of these dyes.

Litmus, *P.B.*

A blue pigment, prepared from various species of *Roccella.*

It is imported from Holland.

Characters and Tests.—Light cubical masses about ¼ inch square, of the colour and appearance of indigo, and the odour of violets. It yields to water, and still more readily to alcohol, a blue colouring matter, and the solution has a reddish hue by reflected light. When heated strongly it does not evolve a reddish violet vapour, nor afford a sublimate of copper-coloured crystals (absence of indigo).

Pharmaceutical Uses.—The preparation of the tincture which is employed as a test.

1. **Tincture of Litmus**, *P.B.*

Prepared by macerating 1 ounce of *litmus* powdered in 10 fluid ounces of *proof spirit* for two days in a closed vessel, and filtering.

2. **Blue Litmus Paper**, *P.B.*

Prepared by steeping unsized white paper in the tincture, and drying by exposure to the air.

Use.—The detection of free acid or an acid salt, both of which change the colour to red.

3. **Red Litmus Paper**, *P.B.*

Prepared by steeping unsized white paper in tincture of litmus, previously reddened by the addition of a minute quantity of sulphuric acid, and drying.

Use.—The detection of alkalies which change it to blue. The alkaline earths, alkaline and earthy sulphides, the soluble borates, phoshate of soda, and the alkaline cyanides have the same effect.

Cudbear and Archil or Orchil are furnished by species of *Lecanora*, chiefly *L. tartarea; Variolaria*, and *Parmelia.* Cudbear is a soft purple powder, formed by keeping the ground lichens moistened with ammoniacal fluid exposed to the air for some weeks, then drying and powdering. Archil is a rich purple liquid prepared in the same way as litmus, the concentrated liquid being preserved in a fluid state, instead of being formed into cakes with foreign matters.

FUNGI, *Juss.* *Mushrooms.*

Fungi generally abound in moist situations, are generated on leaves and stems, are sometimes subterranean, but are most frequently found on organised bodies in a state of decomposition. A few of them are edible, as the common mushroom (*Agaricus campestris*), and truffle (*Tuber cibarium*). *Ammanita muscaria* is remarkable for its intoxicating properties ; many are poisonous. *Amadou*, used as tinder, is made from *P. igniarius*. As *mildew* and *dry rot* they are very destructive to plants and property, and if they have not caused they have at least greatly accelerated disease in the potato and vine. In feeble states of the system they prey on the animal body, constituting various fungous diseases of the skin and mucous membrane, and are supposed as *vibrios* and *bacteria* to germinate septicæmia and pyæmia.

TORULA CEREVISIÆ, *Turpin.* The Yeast Fungus.

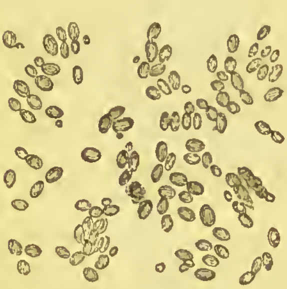

Fig. 59.

Characters.—Ovoid spores about $\frac{1}{5000}$ inch in diameter, free or in chains (fig. 59), under certain conditions rising to the surface, and developing a felt-like mass of white mycelium from which arise numbers of erect filaments terminating in a crowded capitulum of circular spores.

1. **Cerevisiæ fermentum,** *P.B.* *Beer Yeast.*

The ferment obtained in brewing beer.

Characters.—Brownish yellow, viscid, semifluid, frothy, exhibiting under the microscope numerous round or oval confervoid cells. It is composed, according to Mitscherlich, of 47·0 parts of carbon, 6·6 hydrogen, 10 nitrogen, 0·6 sulphur, and 35·8 oxygen. It yields 7·5 per cent. of ash, composed of potassic, sodic, calcic, and magnesic phosphates.

Action and Uses.—It has been recommended by Dr Stokes as a mild laxative, and to improve the condition of the uterine excretions, and as a poultice to correct fœtor. Pereira states that he "has frequently heard patients complain of the great pain it causes" as a local application. This may be due to the presence of imprisoned carbonic acid.

Dose.—½ to 1 ounce.

2. **Cataplasma fermenti,** *P.B.* *Yeast Poultice.*

Preparation.—Mix 6 fluid ounces of *yeast* with 6 ounces of *water* heated to 100°, and stir-in 14 ounces of *wheaten flour*. Place the mass near the fire till it rises.

Bran may be substituted for flour with advantage, as the latter is heavy, and fits the surface to which it is applied so closely that the carbonic acid which is disengaged cannot escape, and so produces painful pressure.

Action and Uses.—A detergent in sloughing or fœtid ulceration.

CLAVICEPS PURPUREA, *Tulasne.* Spurred Rye or Ergot.

Sphacelia segetum, Léveillé. *Oidium abortifaciens*, Link.

Ergot seems to have been first used as a medicine by the profession in France and the United States towards the end of the eighteenth and the beginning of the present century, but in this country not before the year 1824. Its effects seem to have been long known in Germany, and pestilential diseases in early times have been ascribed to eating ergotised grain as food. (See Burnett's *Outlines of Botany*, p. 207).

Characters.—The *mycelium* forms a white, spongy, felted mass, made up of slender thread-like cells (*hyphæ*), the outer layers of which are radially divergent, and constitute the *basidia.* These latter give origin to an immense number of *spores* (*conidia* or *spermatia*), oval cells about $\frac{1}{5000}$ inch long, which accumulate on the surface, giving it a dusty appearance, and becoming detached germinate, and emit filaments. When the fungus germinates on the ground, it produces a number of minute, but stout stems, each of which is surmounted by a globular head of fructification like a sphæria. The stems are sometimes 1 inch in length, and the spherical heads $\frac{1}{10}$ inch in diameter and didymate; they are at first greyish-yellow, but become purple, and are covered with granular elevations, each of which presents a minute orifice. On vertical section these granules are seen to be the outer open extremities of flask-shaped spore sacs (*conceptacula*, *perithecia*, or *asci*) which are arranged within the outer surface of the head in a radial manner. The spores are somewhat glutinous, and issue from the sac in the form of filamentous bundles. The claviceps does not retain its vitality longer than a season.

The fungus usually attacks only a few of the developing fruits of the ear of rye (see fig 60). The first indication of its presence is the deposition of drops of a yellowish intensely sweet slime of fungous odour, called *honeydew*, upon the ears. After a few days the honeydew dries up, and meanwhile the soft ovaries are pervaded by the white mycelium of the young fungus, and become altered in structure, hypertrophied in growth, and assume a very dark purple colour, retaining, however, the original form of the grain of rye.*

Examined by the microscope the structure is homogeneous, being composed of densely matted thread-like cells, with numerous interstices occupied by spherules of oil.

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* Tulasne, from whose account (*Ann. des Science, Nat. Bot.* xx.) the above description is taken, considers that the caryopsides do not undergo *transformation*, but that they are *simply destroyed.* I cannot accept this view, for the simple reason that the diseased grain retains the shape of the normal caryopsis, being only a little curved or cracked.

Ergota, *P.B.* *Ergot.*

The sclerotium (compact mycelium or spawn) of *Claviceps purpurea*, Tulasne, produced within the paleæ of the common rye, *Secale cereale*, Linn. Steph. and Church, *Med. Bot.*, plate 113. It is produced in Southern Russia and Spain, chiefly in Gallicia.

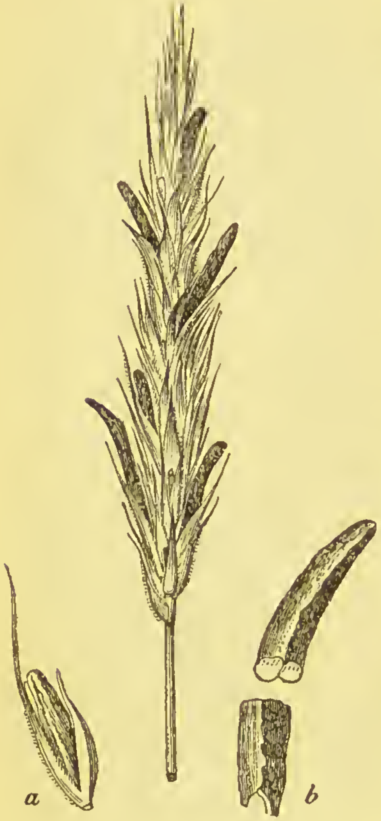

Fig. 60.—*Secale cereale*, infested by the ergot fungus. *a*, an ergotised grain contained within the glumes; *b*, a mature ergot.

Characters and Constituents.—Subtriangular, curved, with a longitudinal furrow on the concave side, obtuse at the ends; from $\frac{1}{3}$ of an inch to $1\frac{1}{2}$ inch long; of a violet brown colour on the surface, pinkish within; solid, frangible, fracture short; odour faintly marked, but strong if the powder be triturated with solution of potash (see p. 337).

Ergot yields 30 per cent. of fixed, non-drying saponifiable, yellowish *oil*, consisting of olein, palmitin, traces of butyric, lactic, acetic, and formic acids; 0·036 per cent. of cholesterin, 7 per cent of resin, 0·1 per cent. of sugar (called *mycose*, because it is rather less dextrogyre than cane sugar), or mannite. 3·2 per cent. of albumin soluble in water; *red colouring matter* soluble in alcoholic solution of ammonia, but insoluble in alcohol, æther, or benzol; and two bases, *ecbolia* and *ergotina*, combined with *ergotic acid*, which is volatile, and yields crystallisable salts. Ganser obtained 0·16 per cent. of ecbolin, and Manassewitz 0·12 per cent. of ergotin. Both have an alkaline reaction, and a bitter taste. They may be separated by mercuric chloride, which forms with ecbolia an insoluble compound. Ganser obtained the hydrochlorate of ecbolia in acicular crystals. Manassewitz gives the following formula for ergotina: $C_{50}H_{52}N_2O_3$. The resin of ergot has feeble irritant properties. Ergotina is but slightly active, the special activity of the drug being due to ecbolia.

Substitutes.—The fungus attacks many of the common species of grass; *Ergot of wheat* is shorter and thicker. *Ergot of oats* is more slender than that of rye. *Ergot of Arundo ampelodesmos* is very long and slender, and is sometimes spirally twisted. Lallement (*Jour. de Pharm.* i. 444) considers it to be more active than that of rye.

Action. Uses.—The effects of ergot were first observed in the diseases produced by it when taken for some time with the ordinary food—that is, in convulsive ergotism and in gangrenous ergotism, both accompanied with formication. In single doses of 30 grains, Dr Wright and others have observed that it created nausea, vomiting, colic pains, and headache, sometimes stupor and delirium. In many cases it has also been observed to depress the pulse. The simple primary action of ergot is that of a stimulant to the involuntary muscular fibre, acting through certain ganglia of the sympathetic nervous system, those supplying the heart escaping early implication. Thus, if full medicinal doses (10 minims of the Liquor ergota) be given to an adult male, the drug will soon produce strong expulsive efforts of the stomach, resulting in retching or vomiting; of the intestines producing diarrhœa, colicky pains, and tenesmus; and of the bladder leading to frequent and painful micturition. In an acute case of poisoning related by Herschel (*New York Med. Soc.* 1874), the effects of ergot were very simply displayed. 30 minims of Squibb's fluid Extract of Ergot given to an infant were soon followed by severe abdominal pain, recurring every fifteen minutes, and lasting one minute, and slight tetanic convulsions of the muscles of the face and extremities. After four hours diarrhœa occurred, and continued for fourteen days. The little patient recovered. But the action of ergot is most prominently shown in its effects on the pregnant uterus. From ten to twenty minutes after the ingestion of the medicine violent uterine contractions are induced, and continue with almost no intermissions until the birth of the child and the expulsion of the placenta. So forcible and continuous is the cramp thus induced, that the child is liable to suffer dangerous compression, or the uterine fibres may be torn by the violence of the contraction. The muscular fibre of the arteries participates in this action, which, if continuous, occludes them, producing dry gangrene of the extremities. The uses of ergot are, therefore, very obvious: as a direct constricter of the blood-vessels, it is an appropriate remedy in both active and passive hæmorrhage; and in the induction of contractions of the uterus it is a most direct and potent agent in promoting abortion, and in rousing the inert uterus to expulsive action. The following general rules should be observed in prescribing the drug in obstetric practice:—1. When to secure the safety of the mother it is necessary to induce premature labour before the seventh month, it may be given, if after separation of the membrane and the use of the douche, uterine contractions do not follow. 2. In natural labour its use should be confined almost exclusively to the treatment of uterine inertia or exhaustion after the birth of the child and the expulsion of the placenta. 3. In very rare cases, and with extreme discretion, it may be necessary to give it to facilitate the expulsion of the child; but in these cases the head must have passed the brim of the pelvis, the os uteri be fully dilated, the perineum lax, and the passage well lubricated by normal secretions. 4. It should not be given for the sole purpose of promoting the expulsion of the placenta; for by producing irregular and persistent contraction of the uterus, it is apt to defeat this object.

Ergot is also very usefully employed to promote the expulsion of hydatiform and polypoid tumours of the uterus, and to restrain hæmorrhage due to the presence of these. I have found it beneficial in controlling hæmaturia arising from ulceration of the mucous membrane of the bladder.

Dose.—20 to 30 grains freshly ground, infused in boiling water for a few minutes, and taken at intervals of half an hour, twice or thrice, until the uterus is roused to action. For menorrhagia, from 5 to 15 grains, taken twice a-day. In order to secure prompt action it may be given subcutaneously, from 5 to 10 minims of the liquid extract being injected into the subcutaneous tissue of the arm or abdomen every fifteen minutes, until the contractions are induced. The following are the preparations in use:—

1. **Extractum Ergotæ liquidum,** *P.B. Liquid Extract of Ergot.*

Preparation.—Wash 1 pint, or a sufficiency, of *æther* with ½ pint of *water*, in order to remove any alcohol, and separate them by decantation. Then, having placed 1 pound of *ergot* in coarse powder in a percolator, free it from its oil by passing the washed æther slowly through it. Remove the marc, and digest it for twelve hours in 3 pints of *water* at 160°. Press out, strain, and evaporate the liquor by the heat of a water-bath to 9 fluid ounces; when cold add 8 fluid ounces of *rectified spirit.* After an hour separate the deposit by filtration. The filtrate should measure 16 fluid ounces.

The object of removing the alcohol from the æther is to avoid the solution of any portion of the ergotin during the removal of the fixed oil.

The removal of the oil is a troublesome, extravagant, and unnecessary process, as its presence does not interfere with the solution of the ergotin in water.

Dose.—10 to 30 minims, corresponding to 10–30 grains of ergot.

2. **Infusum Ergotæ,** *P.B. Infusion of Ergot.*

Preparation.—Infuse ¼ ounce of *ergot* in coarse powder in 10 fluid ounces of boiling *water* for half an hour and strain.

Dose.—1 to 2 fluid ounces. This is hardly suited for the emergencies of labour, where it is usually better to give the finely ground powder in the water in which it has been infused.

3. **Tinctura Ergotæ,** *P.B. Tincture of Ergot.*

Preparation.—Macerate 5 ounces of *ergot* in coarse powder for forty-eight hours in 15 fluid ounces *proof spirit*, with occasional agitation; then transfer to a percolator, and when the fluid ceases to pass continue the percolation with 5 fluid ounces more of *proof spirit.* Afterwards press, filter, mix the liquids, and add sufficient *proof spirit* to make 1 pint.

A superfluous preparation.

Dose.—10 minims to 1 fluid drachm.

4. **Extractum Ergotæ.** *Ergotin. Extractum hæmostaticum.*

The German Pharmacopœia prescribes the following process for the preparation of the solid extract:—Macerate 1 part of coarsely powdered ergot in 2 parts of water for six hours; strain, press, and repeat the process with 2 parts more of water. Evaporate the strained liquors to the consistence of a thin syrup; then add 1 part of dilute spirit, and set aside, with frequent shaking, for a day. Filter and evaporate to the consistence of an extract. It is reddish-brown, has a pungent, bitter taste, and an odour resembling that of roast meat.

Dose.—1 to 5 grains. Dissolved in water or in glycerin, it has been used subcutaneously in doses of ½ to 1½ grain. It is apt, however, to produce considerable irritation of the connective tissue.

LYCOPODIACEÆ, *Decand.* Club-mosses.

Rigid moss-like plants, furnished with axillary spore cases containing powdery matter and spores; allied to mosses and ferns on the one hand, and to coniferous plants on the other.

LYCOPODIUM CLAVATUM. *Common Club-moss.*

Common on the hilly pastures and moors of Central and Northern Europe.

Characters.—*Stems* creeping, many feet long. *Leaves* terminating in long, hair-like processes. *Spikes* in pairs or solitary, cylindrical. *Bracts* cordate, serrate, acuminate. *Capsules* sessile in the axils of the bracts; 1 celled, 2 to 3 valved.

The *spores* are minute, tetrahedral granules, each presenting 4 facets, and are minutely ridged by a hexagonal network.

Lycopodium is a mobile, tasteless, inodorous, straw-yellow powder, a little heavier than water, upon which, on account of its oily nature and the adhesion of air to its netted surface, it floats, and can be wetted with extreme difficulty. Oils, alcohol, æther, chloroform, and benzol immediately adhere to the grains, which sink at once in these fluids. When thrown into a flame it ignites immediately, and with a slight explosion. Dried at 212°, it loses only 4 per cent. of water: it yields to æther or chloroform 47 per cent. of fixed oil, which remains fluid at 5°; the ash, 4 per cent., is chiefly composed of aluminic phosphate.

Substitutes.—Starch, dextrin, the pollen of coniferous trees, all of which are easily recognised by the microscope. Magnesia may be recognised by subsidence and its appropriate tests.

Uses.—For dusting excoriated surfaces, as in intertrigo and eczema, and for preventing the adhesion of pills.

FILICES, *Juss.* Ferns.

The rhizomes of many ferns are astringent, some contain a volatile oil, and some an acrid principle. The fronds are mucilaginous when young, and are used as food in some countries.

ASPIDIUM FILIX MAS, *Swartz.* Male Fern.

The commonest of our indigenous ferns.

Characters.—Fronds annual, 2 to 4 feet long, bipinnate, with oblong, obtusely serrated pinnules. *Sori* circular. *Involucre* reniform. *Sporangium* surrounded by a vertical ring, opening transversely and with elasticity, scattering the *spores.*—*Woodv. Med. Bot.* plate 271.

1. **Filix Mas,** *P.B.* *Male Fern.*

The dried rhizome, with the bases of the footstalks and portions of the root fibres. Collected in summer.

Characters and Constituents.—Tufted, scaly, greenish-brown; powder greenish-yellow, with a disagreeable odour, and a nauseous, bitter, somewhat astringent taste. The rhizome contains 6·9 per cent. of *green fixed oil;* a little *volatile oil;* 4·1 of *resin;* tannin, starch, gum, and crystallisable sugar. It yields 2 to 3 per cent. of ash, composed of phosphates, sulphates, and carbonates of calcium and potassium, and silica. M. Peschier, of Geneva, ascertained that the active principle is soluble in æther. The rhizome yields about 8 per cent. of ætherial extract, which deposits a colourless, crystalline substance, filicic acid, $C_{14}H_{18}O_5$ (according to Grabowski); this, when fused with potash, is resolved into phloroglucin and butyric acid. The green liquid portion of the extract consists mainly of a glyceride of *filixolyn,* which yields by saponification two acids, filosmylic which is volatile, and filoxylic (Luck). The tannic acid is converted by boiling with dilute acid into sugar and filix-red, $C_{26}H_{18}O_{12}$, like cinchona-red (Malin).

Action and Use.—From my observations on the action of male fern, I regard it as a stimulant of the involuntary muscular of the viscus containing it. Thus, an hour or two after taking the liquid extract into the stomach, it produces either vomiting or rapid action of the bowels, with powerful contractions. When injected into the bladder it causes no inconvenience for an hour or more; it is then rejected with strong expulsive efforts, followed by moderate spasmodic irritation for about an hour afterwards. It is clear, therefore, that it has no topical irritant action, and it no doubt acts by producing a peripheral impression, resulting in reflex contraction of the part impressed. This view is supported by the fact that little or none of the extract is absorbed; if it were it would probably produce general contractions of the involuntary system, as is the case with ergot. It is effectually employed to expel tænia and bothriocephalus; and it does so, not by poisoning the entozoon, but by detaching it by force of the powerful peristaltic contractions which also cast it out of the bowel. This action is often followed by considerable prostration.

Dose.—Of the recently prepared powder, 50 to 100 grains. It is usually prescribed in the following form:—

2. **Extractum Filicis liquidum**, *P.B.* *Liquid Extract of Male Fern.*

Preparation.—Pack two pounds of *male fern in coarse powder* closely in a percolator, and pass 4 pints or a sufficiency of æther through it until it passes colourless. Recover the æther by distillation on a water bath, and preserve the oily extract.

According to Soubeiran, 1 pound of the rhizome yields 1½ ounce of the fluid extract.

Characters.—A thick dark green oil, having the peculiar rancid aromatic odour of the fern, and a rancid, bitter, nauseous taste, associated with a coarse violet odour.

Dose.—1 to 3 fluid drachms in the form of emulsion. The dose (15 to 30 minims) prescribed in the Pharmacopœia is ineffectual, because it is usually insufficient to produce peristaltic action of the intestines, without which the entozoon will not be dislodged.

OTHER SPECIES AND GENERA.—The rhizome of the *Aspidium athamanticum*, Kunze, which grows near Port Natal, is stated by Dr Pappe to be in high esteem among the Zoolu Caffres as a vermifuge, especially for tapeworm. It is called *Uncomocomo.*

The silky hairs from the stipe of one or more species of *Cibotium*, imported from Sumatra under the name of *Penghawar*, and from the Sandwich Islands as *Pulu*, have been used as a styptic in Holland.

GRAMINACEÆ, *Juss.* Grasses.

This, the most important family of plants, is found in all parts of the world clothing the earth with verdure, and giving food and fodder to man and animals. The members are herbs or evergreen shrubs with fistular stems, stiffened by a deposit of silica in the epidermis, and sometimes, as in the bamboo, in the joints. Narrow leaves, with a long slit sheath and stipules adherent, forming a membranous ligula. Inflorescence in spikes or panicles. Flowers green, in spikelets, consisting of imbricated bracts, of which the exterior are called glumes, and the interior, immediately enclosing the stamens, paleæ are the characteristics of this order.

AVENA SATIVA, *Linn.* The Oat.

Βρῶμος, Dioscorides.

Characters.—*Panicle* loose. *Spiklets* 2-3 flowered. *Florets* smaller than the glumes, naked at the base, alternately awned. Outer *palea* with lateral nerves, awned, ending in two points. *Awn dorsel*, kneed and twisted. *Stamens* 3. *Ovary* hairy at the top. *Stigmas* 2. *Scales* 2. *Caryopsis* (grain) long, crested, and furrowed. A native probably of Persia. Several varieties are cultivated in Europe.—*Nees von E.* 28.

The grains of oat, when deprived of their integuments, form *groats;* these, when crushed, *Embden* and *Prepared groats.* When the grain is kiln-dried, stripped of its husk and delicate outer skin, and then coarsely ground, it constitutes the *oatmeal* of Scotland.

Oats contain a larger proportion of gluten than any of the other cereals in use. The grain contains about 56 parts of *starch*, 15 of *gluten*, $5\frac{1}{2}$ of *gum* and *sugar*, $4\frac{3}{4}$ of *fat*, 2·5 of *salts*, and about 14 parts of *water* and *lignin* in 100 parts.

Action and Uses.—Groats and oatmeal are nutrient and demulcent. In illness gruel (*Decoctum avenæ*, 1 ounce of oatmeal boiled in 1 pint of water for ten minutes) is a most nutritious and easily digestible food, and may be given strained to infants when the stomach will not digest milk. It is also employed as a demulcent enema.

HORDEUM DISTICHON, *Linn.* Barley.

Barley formed one of the ancient articles of diet (Exod. iv. 31, see *Bibl. Cycl.*). The Hebrew name *shoreh* is very similar to the Arabic *shair*. It is the *ϰϱίθη* of Dioscorides.

Characters.—Several varieties of barley are cultivated. *H. vulgare*, or spring barley, having its grains arranged in 4 rows; *H. hexastichon*, or winter barley, having the same in 6 rows; and the officinal species, *H. distichon*, or common barley. *Spikelets* 3 together. *Glumes* 2, terminating in long awns, with 1 perfect flower, which is distichous, close pressed to the stem, awned, the lateral florets male, awnless, with the upper flower a subulate rudiment placed next the rachis. *Paleæ* 2, the inferior one ending in an awn. *Stamens* 3. *Ovary* hairy at the apex. *Segments* 2, feathery. *Scales* 2. *Grain* oblong internally, with a longitudinal furrow, adherent to the ovary.—Probably a native of Tartary (Reideul).

The grains of barley, deprived of their husks, which, according to Einhoff, amount to 18·75 per cent., form the *Hulled* or *Scotch Barley*, and when ground *Barley Meal*. When the process of decortication is carried further, and the grains become rounded or ovoid, but still retain the mark of the longitudinal furrow, they form the officinal article, *Pearl Barley*. Barley consists of about 48 parts of *starch*, 13 of *gluten*, $7\frac{1}{2}$ of *gum* and *sugar*, 1 of *fat*, $3\frac{1}{2}$ of *salts*, and 26 of *water* and *lignin* in 100 parts.

In the process of *malting* the barley grain is allowed to germinate by a process of sweating (softening it in water and then throwing it in heaps) until the radicle (*acrospire*) has attained the length of half an inch and the plumule is just appearing. Germination is then arrested by spreading the sprouted grain over a perforated floor, and rapidly drying it by a current of air of a temperature not exceeding 90°. When dry the temperature is raised, but not allowed to exceed 140°. The malted grain is then sifted from the separated radicles. 100 parts of dry barley yield 90 parts of malt, the separated radicles carry with them $\frac{1}{9}$th of the nitrogen contained in the grain, and the total loss of nitrogen amounts to 13 per cent of the whole. The germination is attended by the liberation of a considerable quantity of carbonic anhydride, formed at the expense of the starch. A quantity of *diastase* (albuminous ferment), equal to $\frac{1}{500}$ of the weight of the grain, is simultaneously formed.

1. **Hordeum decorticatum,** *P.B.* *Pearl Barley.*

The husked seeds of *Hordeum distichon*, cultivated in Britain.

Characters.—White, rounded, retaining a trace of the longitudinal furrow.

2. **Decoctum Hordei,** *P.B.* *Decoction of Barley.*

Preparation.—Wash 2 ounces of *pearl barley* in cold water, and boil it with 1½ pint of *water* for twenty minutes in a covered vessel, and strain.

Uses.—An emollient, demulcent, and nutritious drink for invalids in fever where the mouth is parched, or in throat affections. 2½ ounces each of stoned raisins, sliced figs, and liquorice root, 2 pints of the decoction, and 1 pint of water, boiled to 2 pints and strained, forms a pleasant substitute.

3. **Extractum Bynes.** *Extract of Malt.*

Preparation.—When the crushed malt, or a mixture of 1 part of malt and 4 or 5 parts of unmalted barley, are digested in warm water for four or five hours, a sweet wort is formed by the action of the diastase on the starch of the grain, which is converted into sugar and dextrine. The preparation of the sweet wort is the first step in the process of brewing, and if, instead of fermenting the wort by yeast, it be evaporated to the consistence of a thick syrup, the so-called extract of malt is procured.

It is a dark-brown treacly fluid, of a pleasant saccharine taste, and fruity odour. It is composed of about 36 parts of *sugar*, 30 parts of *dextrin*, 5·5 of *albumin*, and 1·2 of ash containing 0·5 of *phosphoric acid*, in 100 parts.

Uses.—As an addition to milk, tea, cafè au lait, it may be given to relieve the debility and remove the emaciation produced by continued fever.

TRITICUM VULGARE. Common Wheat.

Wheat is very similar in sound to the Hebrew *khittah*, Arabic *hinteh*, and there is no doubt it was cultivated by and formed the food of the earliest civilised nations. It is the *πύϱοι* of the Greeks.

Characters.—*T. vulgare* var. *hybernum*, the kind commonly cultivated, is sown in autumn and reaped in the following summer. *Spike* 4-cornered, imbricated, with a tough articulated rachis. *Spikelets* solitary, generally 4-flowered. *Flowers* distichous. *Glumes* 2, nearly opposite, equal, the upper one bicarinate; the keels more or less aculeate, ciliate, ventricose, ovate, truncate, mucronate, compressed below the apex, round and convex at the back, with a prominent nerve, awned or awnless. *Stamens* 3. *Ovary* pyriform, hairy at the apex. *Stigmata* 2, feathery. *Scales* 2. *Grain* loose, externally convex and internally marked with a deep furrow.—Cultivated everywhere; said to be a native of Tartary.

Besides this, *T. vulgare*, var. *æstivum*, or spring wheat, is cultivated. *T. compositum*, or Egyptian wheat, is distinguished by its compound spikes. *T. Spelta*, bere or spelt, much cultivated in France, and *T. monococcum*, remarkable for having only a single row of grains, may also be mentioned.

The grain of wheat differs from that of both barley and oats in not adhering to its perianth, so that this is easily separated in the process of threshing. It is reduced into flour (*farina*) by grinding. The *bran*, which consists of from 25 to 32 per cent., according to the variety of wheat, is separated by sifting.

1. **Farina Tritici,** *P.B.* *Wheaten Flour.*

The grain of wheat, ground and sifted.

Flour, according to the analysis of Vauquelin, consists of *Starch*, 68·08; *gluten*, 10·80; *sugar*, 5·61; *gum*, 4·11; *water*, 10·25; but the proportion of these constituents necessarily varies. The ashes of wheat, which amount only to 0·15 per cent., consist, according to Henry, chiefly of the phosphates of soda, lime, and magnesia.

Flour, though officinal, is seldom applied to any medicinal purpose. Its nutritious properties, and its superiority to all other meals for making bread, are well known. Both are dependent on the presence of a large proportion of hygroscopic *gluten*, which is composed of *albumen*, *vegetable fibrine*, *glutin*, and *casein*. The starch and gluten may easily be separated by kneading dough in water, when the particles of starch are washed out, suspended, and afterwards deposited, in the same way as sago, arrowroot, and tapioca, there remains behind a greyish-white, adhesive, and ductile mass. This is gluten.

Pharmaceutical Use.—The preparation of Cataplasma fermenti.

2. **Amylum** (see p. 318).

3. **Panis.** *Bread.*

There are three kinds,—1, yeast bread; 2, leavened bread; and 3, aerated bread. In the preparation of *yeast bread* a sufficient quantity of salt and yeast are added to 1 part of water, and 2 parts of flour are added to the mixture, and kneaded into a paste or dough, and set aside at about 70° for one or two hours, during which the yeast converts a part of the starch into sugar, and the sugar into carbonic anhydride and alcohol; the liberated gas heaves the mass and makes it light and spongy, and when placed in the oven the gas and alcohol are dissipated, and in their efforts to escape from the mass make it cellular. 117 parts of dough yield about 100 of bread. *Leavened* bread is employed by the French; the leaven is a portion of dough kept from the former batch for twenty-hours in a warm place until it undergoes spontaneous fermentation. When mixed with fresh dough it acts as yeast.

Aerated bread is prepared by mixing up the flour under pressure in an iron vessel with water sufficiently salted and charged with carbonic acid, at a pressure of about 3 atmospheres. The kneading is effected by machinery, and when complete an aperture is opened below, and the dough is forced out by the internal pressure of the gas, chopped into equal-sized masses, which are immediately carried by a travelling stage into the oven. The compressed carbonic acid, in its escape from the dough, makes it perfectly light and porous. This is the most wholesome bread for dyspeptic persons.

Alum, and even sulphate of copper, are added to dough, for the purpose of improving the tenacity of the gluten and increasing the whiteness of the bread.

Brown bread, made of the undressed flour, is highly nutritious, and, acting as a stimulant to the mucous surface, it induces increased peristaltic action of the bowels, and is thus very useful in constipation. Bread made with a large proportion of bran and gluten has been used in the treatment of diabetes.

Pharmaceutical Uses.—Bread crumb (*mica panis*) is useful for the formation of pills, and it is employed in the Cataplasma carbonis.

SACCHARUM OFFICINARUM, *Linn.* The Sugar Cane.

It is probable that sugar was first discovered by evaporating the juice of palms in India, of which the sugar is called *jaggarg.* But the sugar of the cane has been known both in India and Egypt from very early times, and the ancients were acquainted with it. (See *Essay on the Antiq. of Hindoo Med.* p. 83.)

Characters.—*Stem* from 6 to 12 feet high, jointed, hard and dense externally, but juicy internally. *Leaves* long, linear, enveloping the stem with their sheaths. *Panicles* 1 to 3 feet long, elegantly diffuse and waving, silvery from the long hairs attached to the florets. *Spikelets* all fertile, in pairs, the one sessile, the other stalked, articulated at the base, 2-flowered; the lower floret neuter with one palea, the upper hermaphrodite with 2 paleæ. *Glumes* 2, membranous, with very long hairs on the back. *Paleæ* transparent, awnless, those of the hermaphrodite flowers minute, unequal. *Stamens* 3. *Ovary* smooth. *Styles* 2, long. *Stigmas* feathered. *Scales* 2, obscurely 2 or 3-lobed at the point, distinct.—*Nees von E.* 33, 34, 35; *Steph. and Church,* pl. 148.

The sugar cane is cultivated from cuttings, and takes about a year to come to maturity. It is then cut down close to the earth, topped, stripped of its leaves, and crushed between iron rollers, or in a wooden mill. The juice is first mixed with lime to saturate the acid which is present, and then heated. The clear liquor is separated and evaporated till it becomes granular. It is then put into casks, the uncrystallisable parts (the *molasses* or *treacle,* see p. 321) allowed to drain off, and the sugar left in the state of the raw, moist, or Muscovado sugar of commerce. The quantity of treacle is diminished, and that of the sugar increased, by employing a less degree of heat, and by boiling *in vacuo.* It undergoes purification in various ways,—by solution in water, refining with albuminous matter, filtration through a stratum of animal charcoal, evaporation, and recrystallisation, and by passing pure syrup through it. When white and pure it forms refined or loaf sugar, and is usually met with in compact conical masses, with a crystalline fracture (see p. 319).

In the East and West Indies it is obtained chiefly from the sugar cane, but in the East also from palms; in France, from the beet root and mangold-wurzel; in America, from the maple; is also found in many fruits, roots, &c.

PALMACEÆ, *Lind.* Palms.

Next to the grasses, the palms form the most important family of plants, furnishing as they do the chief necessaries of life, viz., wood, starch, sugar, milk, oil, fruit, vegetables, and wine in abundance.

SAGUS, SPECIES VARIÆ. The Sago Palm.

Indigenous to the Indian Archipelago, in low swampy lands.

Generic Characters.—*Stem* 20-30 feet high. *Leaves in terminal cluster. Spadix* much branched and sheathed. *Bracts* connate, like a cupule. *Perianth* in 6 divisions. *Stamens* 6. *Stigmas* 3, connate. *Ovary* subtrilocular. *Fruit* coated with reversed scales.

1. S. LÆVIS (*Rumph.*).—Petioles, rachides, and spathes unarmed.
2. S. GENUINA (*Rumph.*).—Petioles, rachides, and spathes prickly.

These and other species, together with the Gommuti Palm (*Saguerus saccharifer*), furnish starch from the interior of their stems, which is imported as *sago meal*,—a whitish starch composed of granules, represented in fig. 56, p. 317, or formed into rounded masses, of which *brown* or *Borneo sago*, and *pearl* or *Malacca sago*, are examples.

ARECA CATECHU. The Areca or Betel-Nut Palm.

This is a tall tree, from 40 to 50 feet high, with a straight stem about 3 feet in circumference. It grows abundantly in Ceylon, Malabar, and Sumatra, and is generally cultivated in tropical Asia. It is the *Foful* of the Arabs.

Characters.—*Leaves* pinnate. *Spadix* branched, enclosed in a double erect spathe. *Flowers* unisexual. *Ovary* 1-celled. *Fruit* drupaceous, the size of a pullet's egg, smooth, yellow, and with a dark fibrous rind. *Seed* solitary, with ruminate albumen.

Areca, *P.B.* *Areca-nut.*

The seed of the plant above described; imported from the East Indies.

Characters and Constituents.—The size and colour of a nutmeg, roundish-conical, flattened at the base, of horny hardness; internally marked with whitish veins; taste astringent. It is composed of tannic and gallic acids, gluten, gum, a little fat, red insoluble matter, and lignin. The inspissated aqueous extract is made into small balls and flat round cakes about 3 inches in diameter, and covered with paddy husks to form a fine kind of catechu called *Coury*. The Ceylon catechu, *Kassu* of Heyne, is believed to have the same origin. It resembles pale catechu in appearance.

Action and Use.—It is used with lime and the betel pepper as a masticatory, and prophylactic against dysentery. It has the same action as catechu. On the evidence of two or three cases, in which the expulsion of tænia has followed its use, it has been introduced into the Pharmacopœia for this purpose, as appears from the dose prescribed.

Dose.—10 to 15 grains of the powder in diarrhœa; from ½ to ¾ ounce as an anthelmentic.

Other Species of Palms.

Phœnix dactylifera, the Date Palm, yields dates, which are the chief article of diet to thousands of Arabs and Africans, and are imported here as an article for the dessert table.

Phœnix sylvestris in India, with *Arenga saccharifera* and *Nissa fructicans* in Indo-China, yield large quantities of sugar by the simple evaporation of their sap.

Cocos nucifera, the Cocoa-nut Palm, one of the most useful of trees, is esteemed on account of the kernel of its fruit (mentioned by Avicenna as the Indian nut), which is not only edible, but yields large quantities of milk and oil.

Elais Guineensis and *E. melanococca* yield the immense quantities of palm oil which are imported from the west coast of Africa. The oil is obtained by bruising the fleshy part of the fruit. It has a solid consistence, is of an orange-yellow colour, and rather a grateful odour. It consists of about 30 parts of the solid fat, *palmitin*, and 70 of *elain*, besides the principles which give it odour and colour. It is emollient, and is sometimes used as an embrocation for spasms and bruises; but it is chiefly employed for making soap.

Calamus Draco, Willd., is one of the species which yields the reddish resinous substance known as dragon's blood (the *dum-al-akhwain* of the Arabs). It is only used for colouring.

Ceroxylon (now *Iriartea*) *andicola* yields wax, as does another palm, called *Carnauba* in Brazil.

Phytelephas macrocarpa.—The seed of this plant constitutes *vegetable ivory*, which is usefully employed as caps to bottles and nozzles to surgical instruments.

IRIDACEÆ. The Iris Family.

This family is known from Amaryllidaceæ by 3 stamens and extrorse anthers. The stigmas are distinct and often petaloid.

IRIS FLORENTINA yields Iris (orrice) root, which is collected chiefly near Florence and Leghorn, and being sent to other parts of the world, finds its way to India, where it is called *Bekhbunufsha* (violet-root). It has a pleasant odour, resembling that of the violet, a bitterish acrid taste, and contains much fecula, with an acrid volatile oil. It is now used chiefly to impart an agreeable odour to the breath and to starch powder (*violet powder*), and in France for making small round balls to keep open issues.

CROCUS SATIVUS, *Linn.* Saffron Crocus.

Crocus is mentioned by Homer and Hippocrates; and as *Carcom* in the Old Testament. It is the *kurkoom* of the Persians and *zafran* of the Arabs. Saffron was early cultivated in Egypt and Persia. Dr Royle obtained it from Cashmere (see *Himal. Bot.* p. 2). It has long been introduced into Europe. Saffron Walden was so named from its being cultivated there.

Characters.—*Corm* roundish. *Leaves* narrow, with a white midrib. *Perianth* regular, funnel-shaped, with a long tube; limb bell-shaped, light purple, preceding the leaves, throat bearded. *Stigmas* deep orange-coloured, in 3 deep wedge-shaped linear divisions, notched at the extremity. *Capsule* oval, 3-celled, many seeded.—*Steph. and Church. Med. Bot.* pl. 101.

1. **Crocus**, *P.B.* *Saffron* or *Hay Saffron.*

The dried stigma, and part of the style, imported from Spain, France, and Italy.

Characters.—Thread-like styles, each terminated by 3 long orange-brown stigmas, broadest at the summit. Odour powerfully aromatic. Rubbed on damp paper it leaves an intense orange tint. When pressed between folds of white filtering paper it leaves no oily stain.

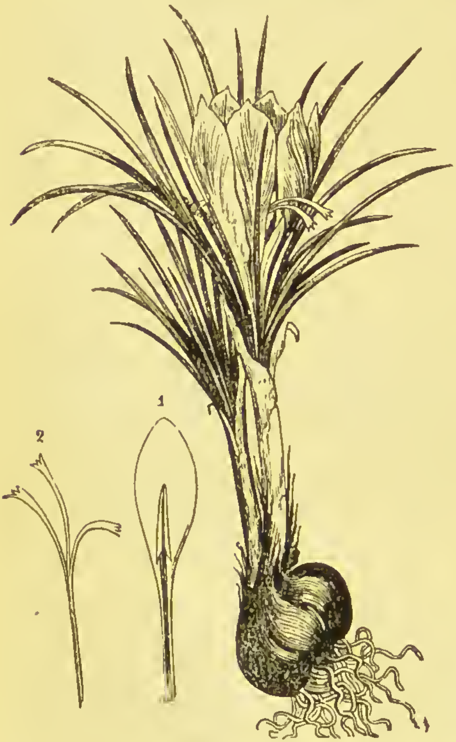

Fig. 61.—*Crocus sativus.* 1. Outer div. of *perianth* with *stamen.* 2. *Stigmas.*

Adulteration.—Saffron is an expensive article, since the produce of about 60,000 flowers only weighs a pound, and it is therefore very liable to adulteration. Prof. Bentley has pointed out that the anthers are sometimes mixed with the stigmas. The florets of *Carthamus tinctorius*, or Safflower, has been used as an adulteration. As they are the florets of an asteraceous flower, they are easily recognised by a pocket lens after the saffron has been expanded in a little water. But the most subtle sophistication is saffron which has been exhausted by previous use. It may be known by isolating a number of stigmas, and treating each separately with a little water in a test tube; the exhausted stigmas will yield little or no colour. An article called *Cake Saffron* is in common use in England as a substitute for hay-saffron. It is in moist flat reddish-brown cakes, about the size of a pancake, ½ inch thick, and is composed of the petals of safflower made into a paste with sugar or treacle and gum.

Action and Uses.—Saffron is a feeble stimulant and diaphoretic. It is given to young children to encourage the development of exanthematous rashes; and is used as a colouring and flavouring ingredient.

Pharmaceutical Uses.—In the preparation of Decoctum aloes compositum, Pilula aloes et myrrhæ, Pulvis cretæ aromaticus, Tinctura cinchonæ composita, T. opii ammoniata, T. rhei; and the following:—

2. Tinctura Croci, *P.B. Tincture of Saffron.*

Exhaust 1 ounce of saffron with 1 pint of proof spirit, in the manner directed for Tinctura aconiti.

Dose.—1 to 4 fluid drachms.

ZINGIBERACEÆ, *Lind.* Ginger Worts.

So closely allied to the Marantaceæ as to be only distinguished by the following trivial characters: aromatic or pungent properties, the single fertile stamen, the inner series of the corolla more regular, but the one division enlarged to form a labellum, the fertile stamen *opposite* the labellum, and a *two*-celled anther. In the reduction of the stamens to one, both orders approach the Orchidaceæ. The characters of the Zingiberaceæ are well illustrated in the following plants.

ZINGIBER OFFICINALE, *Roscoe.* The Ginger.

Ginger, the *ζιγγίβερις* of Dioscorides and *zinjàbil* of the Arabs, seems to derive its name from the Sanscrit *shringaveram.* Pliny says it was thought to be the root of pepper, and called *zimpiperi,*—"quanquam *sapori simile.*"

Characters.—*Rootstock* biennial, creeping. *Stem* annual, erect, 3 or 4 feet high, enclosed in the sheaths of distichous leaves. *Leaves* subsessile, linear-lanceolate, smooth. *Spikes* radical but elevated, oblong-obovate, strobiliform, formed of single-flowered, imbricated, acute bracts. *Corolla* with outer limb 3-parted, the interior unilabiate. *Lip* 3-lobed. *Stamens* 3, two abortive, the fertile one opposite the labellum. *Anthers* double, crowned with a single incurved beak. *Capsule* 3-celled, 3-valved. *Seeds* many, arilled.—*Nees von E.* t. 61; *Roscoe, Trans. Linn. Soc.; Woodv. Med. Bot.* pl. 11.

Ginger is propagated from cuttings of the rootstocks. The young rhizome is preserved in syrup, having been first scalded and scraped; it then forms *Preserved Ginger.* In the autumn the rhizomes are taken up and scalded in hot water to stop vegetation; they are then dried, when they form what is called *Black Ginger*, or, being scraped, *White Ginger.* Most of the *black*, or unscraped ginger of commerce, is brought from the East Indies, where it is cultivated both in the plains and mountains. The *white* ginger comes principally from the West Indies, but some has lately been exported from Malabar. Much is further whitened by being bleached with chloride of lime, &c.

1. Zingiber, *P.B. Ginger.*

The scraped and dried rhizome of *Z. officinale*, from plants cultivated in the West Indies, India, and other countries.

Characters and Constituents.—More or less branched, regularly zig-zagged decorticated pieces, 3 to 4 inches long; subcompressed; yellowish-white, but not chalky on the surface, with a short mealy fracture; hot taste and agreeable aroma; powder yellowish-white. It is chiefly composed of starch pervaded by fibres of lignin, a little gum, bassorin, a very acrid resin, and a *volatile oil* (C_5H_8) which is the essential constituent, having the agreeable aroma and burning taste of ginger; sp. gr. 0·893.

Action and Uses.—A grateful, stimulating aromatic, and sialogogue, useful in atonic dyspepsia and flatulent colic. Externally it is rubefacient and errhine. It is combined with purgatives to prevent griping.

Dose of the powder.—5 to 30 grains.

Pharmaceutical Uses.—An adjunct to Confectio opii, C. scammonii, Infusum sennæ, Pilula scillæ composita, Pulvis cinnamomi compositus, P. jalapæ comp., P. opii comp., P. rhei comp., P. scammonii comp., Syrupus rhamni, and Vinum aloes; and for the preparation of the following:—

2. **Tinctura Zingiberis,** *P.B. Tincture of Ginger.*

Preparation.—Exhaust 2½ ounces of *ginger in coarse powder* by 1 pint of *rectified spirit*, in the manner directed for Tinctura aconiti, so as to obtain 1 pint of tincture.

Dose.—15 minims to 1 fluid drachm.

3. **Tinctura Zingiberis fortior,** *P.B. Strong Tincture of Ginger.*

Preparation.—Pack 10 ounces of *ginger* in fine powder tightly in a percolator, and pour in half a pint of *rectified spirit*. After two hours add more spirit, and let it percolate slowly until 1 pint of tincture has passed.

Dose.—5 to 20 minims as a warming stomachic. It is used to prepare the following:—

4. **Syrupus Zingiberis,** *P.B. Syrup of Ginger.*

A mixture of 6 fluid drachms of *strong tincture of ginger* and 19 fluid ounces of *syrup*.

Dose.—1 fluid drachm.

CURCUMA LONGA, *Linn.* Turmeric.

This appears to be the κύπειρος Ἴνδικος of Dioscorides; but the name is no doubt derived from the Persian *kurkoom*. Turmeric is cultivated throughout India, and in China and Java, being employed as a condiment by the natives.

Characters.—*Rhizome* perennial, having many elongated yellow ramifications; with numerous root-fibres proceeding from the rhizome, many of which, as in Maranta, swell into white tubers. *Leaves* radical, bifarious, with long sheathing petioles, broad, lanceolate, of an uniform green. *Scape* from the midst of the leaves, short, and formed into a spike by numerous imbricated and united bracts, in the lower only of which are from 3 to 5 flowers, supported by bracteoles. *Corolla* with a tube gradually enlarged upwards;

limb double, each 3-parted. *Anther* incumbent, bicalcarate at the base. *Style* capillary. *Capsule* 3-celled. *Seeds* numerous, arillate.—*Bot. Reg.* t. 1825; *Nees von E.* pl. 59, as *Amomum Curcuma.*

1. **Turmeric,** *P.B.*

The ramifications of the rhizome form turmeric, while arrow-root is procured from the white tubers, as in Maranta. Turmeric is sometimes divided into *round* and *long* kinds, but both are found on the same plant. The latter is most common, about the size of the little finger, curved, pointed, and marked externally with transverse annular wrinkles, of a yellow colour, but somewhat of a reddish-brown internally. The powder is bright-yellow. The odour of turmeric is peculiar, usually very conspicuous in curry powder. The taste is warm and bitterish, but spice-like. It contains *starch* dyed by a yellow colouring matter, and an odorous acrid *volatile oil.*

Action. Uses.—Turmeric is a mild aromatic, and much employed as a condiment. It is also used in dyeing.

Pharmaceutical Uses.—In the preparation of the following:—

2. **Tincture of Turmeric,** *P.B.*

Prepared by macerating 1 ounce of bruised *turmeric* in 6 fluid ounces of *rectified spirit* for seven days and filtering.

3. **Turmeric Paper,** *P.B.*

Prepared by steeping unsized white paper in tincture of turmeric, and drying it by exposure to the air.

Use.—To detect alkali, which turns it brown.

ELETTARIA CARDAMOMUM, *Maton.* Malabar Cardamom.

Like the other Zingiberaceous plants, a perennial herb, native of the Malabar coast in Wynaad and Coorg, where it springs up spontaneously in the clear spaces left after felling large trees and clearing away the underwood.

Characters.—*Rhizome* with numerous fleshy fibres. *Stems* from 6 to 9 feet high. *Leaves* lanceolate, acuminate, pubescent above, silky beneath. *Scapes* from the base of the stem flexuose, procumbent. Outer limb of the corolla in three oblong lobes, inner a single lip. *Anther* of two distinct lobes. *Filament* with two transverse lobes at the base, emarginate, and simple at the summit. *Capsule* of 3 cells and 3 valves.—*Trans. Linn. Soc.* x. t. 4 and 5; *Nees von E.* 66; *Steph. and Church,* pl. 106.

In the February or April, of the fourth year, four or five flowering suckers are seen to spring from the stem near the root. The fruit of these is ripe by the following November, when it is collected, and requires only drying in the sun.

1. **Cardamomum,** *P.B.* *Cardamom.*

The dried capsules of the Malabar cardamom, cultivated in Malabar. The seeds are best kept in their pericarps, from which they should be separated when required for use, the pericarpial coats being rejected.

Characters and Constituents.—Seeds obtusely angular, wrinkled, reddish-brown, internally white, with a warm, agreeably aromatic taste and odour, contained in ovate-oblong, triangular, pale-brown, coriaceous, ribbed pericarps.

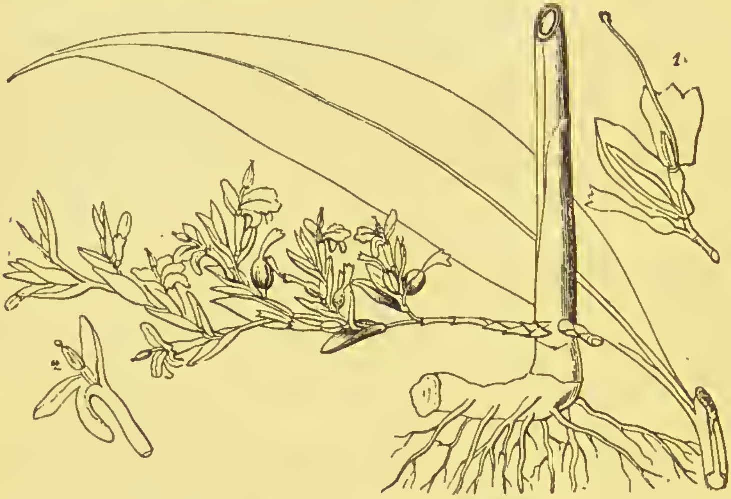

Fig. 62.—Elettaria Cardamomum.

The seeds yield to alcohol 12½ per cent. of oil, resin, and extractive matter containing the active constituents. The seeds contain 10·4 per cent. of *fixed oil*, an *acrid resin*, and about 4 per cent. of *volatile oil*. The ash is rich in manganese. The volatile oil has the taste and odour of the seeds, sp. gr. 0·93, and is composed of a liquid portion, and a crystalline camphor isomeric with turpentine camphor ($C_{10}H_{16}3H_2O$).

Action and Uses.—Those of ginger, but it is more aromatic. Employed as an adjunct to other carminatives, and to aperients.

Pharmaceutical Uses.—An adjunct to Extractum colocynthidis compositum, Pulvis cinnamomi compositus, P. cretæ comp., Tinctura gentianæ composita, T. rhei comp., Vinum aloes; and furnishes the essential constituent of the following:—

2. **Tinctura Cardamomi composita**, *P.B. Compound Tincture of Cardamom.*

Prepared by exhausting the following ingredients with 1 pint of proof spirit in the manner directed for Tinctura aconiti, and making up the mixture to 1 pint:—¼ ounce of *cardamom seeds* freed from pericarps and bruised, ¼ ounce of bruised *caraway* fruit, 2 ounces of *raisins* freed from seeds, ½ ounce of *cinnamon* bark bruised, and 60 grains of *cochineal* in powder.

Dose.—½ to 2 fluid drachms.

Pharmaceutical Uses.—A constituent of Decoctum aloes compositum, Mistura ferri aromatica, M. sennæ composita, and Tinctura chloroformi composita.

The Melegueta Pepper or **Grains of Paradise.**

Which are exported from Sierra Leone, and largely employed in England for the adulteration of beer, are produced mainly by *Amomum melegueta*, Roscoe.

MARANTACEÆ, *Lind.* The Arrowroot Family.

These plants are typified by the well-known Canna so common in our gardens. They are distinguished from Zingiberaceæ by the following trivial characters:—Absence of pungency and aroma, a little increase in the irregularity of the corolla, the fertile stamen to one or other side of the labellum, the anther 1-celled, and the filament petaloid.

MARANTA ARUNDINACEA, *Linn.* Arrowroot.

The fecula, root-stocks, and tubers of this plant have long been familiar to the inhabitants of South America; but West Indian arrowroot has only been used in England during this century.

Characters.—Rhizome white, horizontal, annulated, from which proceed root-fibres, some of which swell into tubers, and become jointed stocks, similar to the rhizoma, but covered with scales. These often elongate, curve upwards, and rising out of the ground, become new plants. *Stem* 2–3 feet high, much branched, slender, finely hairy, tumid at the joints. *Leaves* alternate, with long, leafy, hairy sheaths, ovate, lanceolate. *Panicles* terminal, lax, spreading, with long, linear, sheathing bracts at the ramifications. *Calyx* green, smooth. *Corolla* white, small, unequal, one of the inner segments in the form of a lip. *Anther* attached to the petal-like filament. *Style* hooded, petal-shaped. *Ovary* 3-celled, smooth. *Stigma* 3-sided. *Fruit* even, dry, 1-seeded.—See *Nees and Ebermair, Pfl. Med.* 69 and 70.

The starch or arrowroot is obtained by beating into a pulp one-year old tubers (the rhizoma does not seem to be used, either of this or of the Curcumas), then throwing this into water, agitating and straining it so as to separate the amylaceous from the fibrous portion. When allowed to stand, the starch subsides, is washed with a fresh portion of water, and afterwards dried in the sun. It is then snow-white, and is composed of minute granules, from $\frac{1}{1000}$th to $\frac{1}{750}$th in size (see fig. 55, p. 317).

Besides the West Indies, the *Maranta* is now cultivated with great success at Natal, and in other British colonies.

In India, *Maranta arundinacea* has been successfully cultivated near Calcutta. Some arrowroot is yielded by another species, *M. ramosissima.* Besides these, much (called *East Indian arrowroot*) is yielded by *Curcuma angustifolia, leucorrhiza, rubescens*, &c.; but the greater portion of the arrowroot exported from India is produced in Travancore, and we have no information respecting the species which yields it, as *Curcuma angustifolia* has not been proved to be indigenous there. Some is also made in India from the tubers of *Ipomœa Batatas.* In Europe, potato starch is often substituted for arrowroot.

CANNA, SPECIES VARIÆ. Indian Shot or Tous les Mois.

The following species furnish Tous les Mois:—*C. edulis* (*Bot. Reg.* ix. 775), *C. coccinea*, *C. glauca*, and *C. Achiras*.

Tous les Mois is produced in the West Indies by *C. edulis*, which is cultivated at Barbadoes, St Kitts, and the French islands, and attains in rich soils the height of 14 feet, and has tuberous roots equal in size to the human head. The starch grains of tous les mois are very large (see fig. 54, p. 317).

Action. Uses.—Arrowroot participates in all the properties of starch (see p. 318), and is nutritious and demulcent. It is well adapted for the diet of the sick, convalescents, and for infants when weaned. Used as a demulcent in urinary and bowel complaints. Arrowroot makes a firmer jelly than most of the feculas, with the exception, perhaps, of that of tous les mois.

ORCHIDACEÆ, *Juss.* Orchids.

This order is closely allied to Marantaceæ and Zingiberaceæ, the chief feature being the fusion of the fertile stamen with the pistil to form the column, the adhesive character of the pollen, and the extremely developed irregularity of the inner series of the perianth.

The Orchidaceæ, though so interesting to horticulturists, are of very limited importance in medicine. They yield but two products —Salep and Vanilla.

1. Salep, *Salop*, *Saloop*. Arab. *Salib*. Hind. *Sálib miorí.*

Is prepared in Central Europe, Turkey, Asia Minor, and in Northern Asia, from the tubers of our indigenous species of orchis, viz., *Orchis bifolia*, *O. mascula*, *O. militaris*, *O. morio*, *O. pyramidalis*, *O. ustulata*, as well as others. In India, the finest salep is procured from species of *Eulophia*, *E. campestris*, and *E. herbacea*. According to Dost Mahommed, the finest salep is produced near Candahar.

The tubers are dug up and dried, during which process they become hard and horny, and lose their bitter taste and unpleasant odour. Levant salep occurs in the form shrunken, contorted, horny, ovoid tubers, about ½ to 1 inch long. When macerated in water they imbibe it and regain their original form and consistence. Salep is composed of 48 per cent. of mucilage, soluble in cold water, and rendered blue by iodine; it forms a jelly with 40 parts of water, is soluble in ammoniacal oxyde of copper, and when boiled with nitric acid, yields oxalic acid. It, therefore, resembles the mucilage of starch rather than that of gum. Salep also contains starch, a little sugar, and albumin, and yields 2 per cent. of ash.

Uses.—Salep is regarded by Eastern nations as an aphrodisiac, a notion derived from the form and appearance of the root. As a nutritious and unirritant diet it is given to invalids with milk in the form of decoction or jelly.

2. **Vanilla.** F. and G. *Vanille.*

The pod of the *Vanilla planifolia*, Andrews, which is indigenous to Eastern Mexico, growing on trees in damp and shady situations. It produces a long fleshy fruit about ¾ of an inch thick. When dry it forms a rich brown flexible stick-like pod, 3 to 8 inches long, ¼ to ½ inch broad, longitudinally wrinkled and greasy, often presenting white specs composed of minute crystals. The pod splits into two unequal valves, and discloses the minute black seeds imbedded in a brown viscid extract. The pericarp is pervaded by spherules of yellowish oil, and crystals of calcic oxalate and the aromatic principle vanillin or vanillic acid. *Vanillin*, according to Charles, has the composition $C_{16}H_8O_6$; it exists in the proportion of about 1 per cent., forms 4-sided acicular prisms, of a vanilla odour, and slightly acrid taste; they fuse, and may be sublimed unchanged; it is soluble in 11 parts of boiling water, and freely in volatile and fatty oils, in alcohol, and in æther. Its solutions redden litmus. It has, in fact, acid properties, and is therefore appropriately called *vanillic acid;* it is, however, unable to decompose the carbonates when heated with them. Vanilla also contains 11·8 per cent. of fat or waxy matter, 4·0 of resin, 16·5 of gum and sugar, and yields 4·6 per cent. of ash (Leutner).

According to the late researches of Tismann and Haarmann, vanillin is the methylic aldehyd of protocatechuic acid, $C_7H_6O_4$, and may be obtained artificially by oxydising coniferin, $C_{16}H_{22}O_8,2H_2O$, a substance existing in the sapwood of pines, by means of potassic bichromate and sulphuric acid.

Uses.—Vanilla is employed for imparting its delicate and grateful flavour to cognac, chocolate, ices, and other confectionery. A tincture may be used for flavouring certain medicines.

ORONTIACEÆ, *R. Brown.* Orontiads.

The curious plants Anthurium, Monstera, and Dracontium, so abundant in the Grecian House in Kew Gardens, illustrate this family. They differ from the Arums in having hermaphrodite flowers and usually a sealy perianth. The rhizome of *Calla palustris* is violently acrid. The leaves of Monstera are used by the Indians of Demerara as a vesicant. Aceras is aromatic.

ACORUS CALAMUS, *Linn.* Sweet Flag.

The ἄκορον of the Greeks, the *wuj* of the Arabs, and *buch* of the Hindoos. It is indigenous.

Characters.—*Rhizome* thick, rather spongy, aromatic like every other part of the plant. *Leaves* erect, 2–3 feet high, about an inch broad, bright green. *Stalk* 2-edged or leaflike, but thicker below the *spadix*, which issues from one of the edges, about a foot above the root, 2 or 3 inches long, tapering, covered with numerous thickly-set pale-green flowers.—*Steph. and Church*, pl. 32; *Nees von Esen*, pl. 24.

The rhizome, which throws up leaves from its upper, and roots from its lower surface, is flattened, jointed, or marked with the semi-circular impressions of the leaves, of a light-brownish colour externally, with a reddish tinge internally. The odour is strong and aromatic, but not very agreeable; the taste warm, bitterish, aromatic, and a little acrid. It contains *volatile oil* and *acrid resin.*

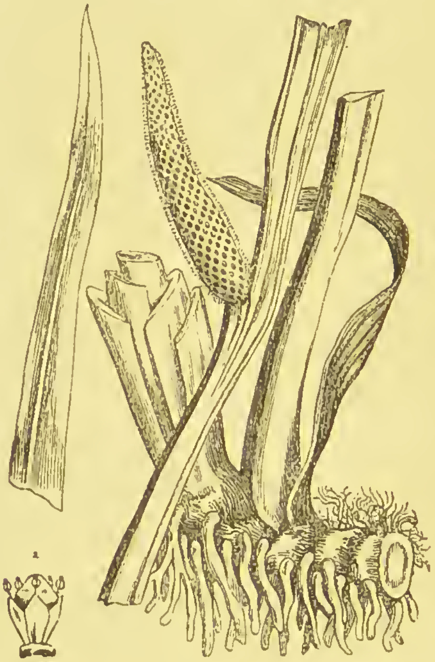

Fig. 63.—*Acorus calamus.* *a*, flower.

Action. Uses.—The rhizome is an aromatic stimulant. Dr Royle has frequently prescribed it in conjunction with chiretta and bonduc nut with success as an antiperiodic in ague. In powder in doses of 10 to 20 grains, or in infusion (2 ounces to 1 pint) in doses of 1 to 2 ounces.

MELANTHACEÆ, *R. Brown.* The Colchicum Family.

These plants are very closely related to Liliaceæ, from which they are distinguished by their extrorse anthers, and septicidal dehiscence of their carpels. Colchicum resembles a crocus in appearance, but is known by its 6 stamens.

COLCHICUM AUTUMNALE, *Linn.* Colchicum or Meadow Saffron.

Colchicum is well described by Dioscorides. It was used by the Arabs, and is their *sorinjan;* they give *kuljikoon* as its Greek name. The Hermodactyls (sweet and bitter *sorinian* of the Arabs) of the later Greeks and Arabs were no doubt species of this genus. Dale, Miller, Guibourt, and lastly Planchon, all of whom, as well as others, have directed attention to this subject, have fixed especially upon *Colchicum variegatum*, Linn.

Colchicum is indigenous, and the fields in some parts are purple with its blossoms in September. The midland counties afford the chief supply of corm and seed.

Characters.—Rhizome a *corm, root* fibrous. *Leaves* broadly lanceolate about a foot long, dark green and shining, appearing in the *spring* with the fruit. *Flowers,* several appearing in *autumn* without the leaves, lilac or purple; *perianth* 6-parted, terminating in a long white tube. *Stamens* six, inserted into the throat of the tube, *anthers* extrorse. *Styles* 3 long filiform. *Capsule* 3-celled, opening through the dissepiments. *Seeds* numerous.—*Nees von E.* plate 49; *Woodv. Med. Bot.* plate 177.

The corm is biennial; it buds off from the parent at the end of June, flowers in the autumn of the following year, and produces its fruit in the succeeding summer; it then shrivels, and begins to disappear.

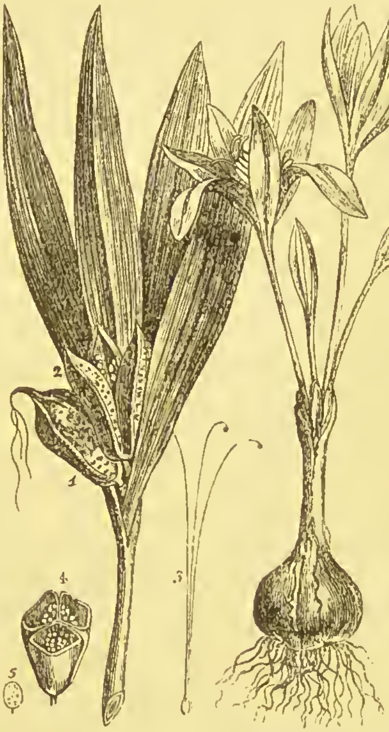

Fig. 64.—*Colchicum autumnale.* 1, fruit; 2, dehiscent; 3, styles; 4, fruit in section; 5, seed.

1. Colchici Cormus, *P.B.* *Colchicum Corm.*

The fresh corm, collected about the end of June; and the same stripped of its coats, sliced transversely, and dried at a temperature not exceeding 150.°

Characters.—Fresh corm about the size of a chestnut, flattened where it has an undeveloped bud; furnished with an outer brown and an inner yellow coat; internally white and fleshy; yielding when cut a milky acrid and bitter juice. Dried slices flat, about a line thick, reniform, firm, whitish, and amylaceous. It is intended that the corm be collected at the time of its complete development, and before it has exhausted itself by flowering or the production of a young corm, *i.e.*, as the leaves are withering, and just before the flower appears when it is just a year old.

2. **Colchici Semina**, *P.B.* *Colchicum Seeds.*

Characters.—The fully ripe seeds spherical. About the size of black mustard seeds, very hard and bitter, dark reddish brown, dull, and wrinkled.

The *active constituent* of the corm seed is *colchicia*, $C_{17}H_{19}NO_5$, an alkaloid of bitter but not acrid taste, crystallising in slender prisms, and furnishing bitter crystallisable salts with acids. It is soluble in water and alcohol, and does not excite sneezing like the closely-allied substance veratria. Nitric acid turns it deep violet. It is a very active poison.

Action and Use.—Colchicum is *irritant* and *sedative*, the second effect being a consequence of the first. Thus large doses produce nausea, vomiting, and purging, followed by pallor, cold sweats, feeble and usually intermitting pulse and syncope, and attended by griping pain, abdominal tenderness, tenesmus, and in extreme cases bloody stools and intense enteritis, with inflammation of Peyer's patches and tympanites. Small doses are nauseant, cathartic, diuretic, and diaphoretic, thus generally exciting the secretory organs. When these effects are induced, a sedative action on the circulatory organs is manifest, arterial throbbing and tension is diminished, and pain proportionally relieved. Such being the operation of the plant its use is apparent. It cannot be given in febrile disorders associated with disorder of the alimentary canal, but in almost all other conditions of pyrexia and pain it may be advantageously employed. Thus in the painful disorders, gout and acute rheumatism, it is particularly suitable, and so beneficial that it has been long regarded as specific in the former of these diseases. It may be given with advantage in hepatitis or mere congestion of the liver.

Dose.—The powdered corm or seeds may be given in doses of 1 to 5 grains twice a day, or every hour until nausea or diarrhœa is induced.

Pharmaceutical Uses.—1. Of the corm, the preparation of Extractum colchici, E. colchici aceticum, Vinum colchici. 2. Of the seed, Tinctura colchici seminum.

3. **Colchici Extractum**, *P.B.* *Extract of Colchicum.*

Preparation.—Crush 7 pounds of *fresh colchicum corms* deprived of their coats, press out the juice, allow the starch to subside, and heat the clear liquor to 212° (to coagulate the albumen), then strain through flannel, and evaporate by a water-bath at a temperature not exceeding 160° until the extract is of a suitable consistence for forming pills.

Dose.—$\frac{1}{2}$ to 2 grains.

4. **Extractum Colchici aceticum**, *P.B.* *Acetic Extract of Colchicum.*

Preparation.—Crush 7 pounds of *fresh colchicum corms* deprived of their coats, add 6 fluid ounces of *acetic acid*, and press out the juice, &c., proceeding exactly as directed for Extractum colchici, in order to obtain a soft extract.

Dose.—½ to 2 grains.

5. Vinum Colchici, *P.B.* *Colchicum Wine.*

Preparation.—Macerate 4 ounces of *colchicum corm,* sliced, dried, and bruised in 1 pint of *sherry* for seven days, with occasional agitation; press, and strain through calico; then add sufficient sherry to make 1 pint.

Dose.—10 to 30 minims twice or thrice a day; or, in a case of acute gout, a single dose of 1 to 2 fluid drachms, so as to cause nausea and a free action of the bowels.

6. Tinctura Colchici seminum, *P.B.* *Tincture of Colchicum Seeds.*

Prepared by exhausting 2½ ounces of *bruised colchicum seeds* with 1 pint of *proof spirit,* and forming 1 pint of tincture in the manner directed for Tinctura aconiti.

Dose.—10 to 30 minims twice or thrice a day; or a single dose of 1 to 2 fluid drachms, to produce nausea and purging.

VERATRUM ALBUM, *Linn.* White Hellebore.

A native of moist localities in Central and Southern Europe.

White hellebore is believed to be the Ἑλλεβόϱος λευκός of Dioscorides, the *Khirbuk abiuz* of the Arabs.

Characters.—*Rootstock* rugose, oblong, præmorse, rather horizontal; when dry it is of a brownish colour on the outside, but internally of a greyish colour, with long cylindrical radicles. The *stem* is 1½ to 4 feet high. *Leaves* plicate, elliptic, or elliptico-lanceolate, pubescent below, passing obliquely into the sheath. *Racemes* paniculate, terminal, pubescent. *Flowers* polygamous, yellowish-white, green at the back. Segments of 6-parted *perianth* oblong-lanceolate, denticulate, without glands at the base, spreading, much longer than the pedicle. *Stamens* 6, inserted into the base of the segments; *anthers* reniform, opening transversely. *Ovary* with 3 spreading stigmas. *Capsules* 3, united below, horned above, separating into 3 many-seeded follicles. *Seeds* compressed, or winged at the apex—Meadows in the south of Europe, and also in Central Europe.—*Nees von E.* 46; *Steph. and Church,* 136.

All parts of this plant are acrid and poisonous; but the rootstock with its radicles is alone used. It is usually imported from Germany, and is rough with the remains of the detached radicles. It is at first a little sweetish, but its bitter and acrid disagreeable taste soon overwhelms every other. The properties depend chiefly on the presence of *veratria,* but another alkali has been detected by E. Simon, which he has called *jervia,* which in Spanish signifies poison $(C_{30}H_{46}N_2O_3,2H_2O)$.

Action. Uses.—A violent irritant, producing like colchicum vomiting, purging, pain, tenesmus, and sometimes bloody evacuations attended by great prostration. Applied to the nose, it induces sneezing and coryza. It used to be employed as a hydragogue cathartic, and as an anodyne in gout. It is now chiefly used to destroy pediculi; sometimes as an errhine, one grain being mixed with ½ ounce of starch or Florentine iris root.

Vinum Veratri. *Veratrum Wine.*

Preparation.—Macerate 8 ounces of *sliced white hellebore* in 32 fluid ounces of *sherry wine* for seven days. Strain. (Pharm. Lond.)

Action. Uses.—Emetic, cathartic, anodyne. Sometimes used in gout and rheumatism.

Dose.—10 minims thrice a day.

VERATRUM VIRIDE, *Willd.* Green Hellebore.

This plant closely agrees, in botanical characters and active constituents, with the foregoing, and resembles it completely in physiological action. *Veratrum viride* is known in the U.S. as *American Hellebore*, *Swamp Hellebore*, *Indian Poke*, and *Poke Root.* Its action has been described by Dr C. Osgood in the *Amer. Journal of Med. Sciences*, vol. xvi.

Characters.—*Rhizome* thick and fleshy, upper part truncated, lower fleshy, with numerous white radicles. *Stems* annual, round, striated, pubescent, solid, 3–6 feet high, terminating in a panicle of greenish-yellow flowers. *Leaves* bright green, decreasing in size as they ascend, lower 6–12 inches long, oval-acuminate, pubescent, waved, plaited, amplexicaul; upper oblong, lanceolate. *Panicle* of numerous flowers in racemes with downy peduncles. *Bracts* downy, pointed, longer than pedicel. *Perianth* in 6 oval-acute segments, 3 longer than others. *Stamens* 6, filaments recurved. *Pistils* 3, styles recurved. *Fruit* of 3 capsules, separating at the top, and along the inner edge. *Hab.*—Swamps, wet meadow, and banks of streams, from Canada to the Carolinas.

1. Veratri viridis radix, *P.B. Green Hellebore Root.*

The dried rhizome, collected in autumn in the United States and Canada. It resembles *Veratrum album* in appearance; but is sometimes sliced; and its active constituents are the same, viz., *veratria* and *jervia.* It has a bitter, acrid taste.

Action and Uses.—Identical with those of *Veratrum album.* It is *irritant* and *sedative* like colchicum, which it also closely resembles in action; but it is less irritant, and more directly sedative, so that it may be said to occupy a position intermediate between colchium and digitalis. Applied externally, it is irritant; given internally in moderate doses, it excites vomiting with a tendency to syncope, and purging. Smaller doses produce nausea and diminution in the force and frequency of the pulse. It is serviceable in fever, especially rheumatic fever, and in acute local inflammations. Owing to its powerfully depressent action it must be given with great caution.

Dose.—4 to 6 grains of the powder cause emesis. Smaller quantities are antiphlogistic. It is usually given in the following form:—

2. Tinctura Veratri viridis, *P.B. Tincture of Green Hellebore.*

Prepared by exhausting 4 ounces of *green hellebore root in coarse powder* with 1 pint of *rectified spirit*, as directed for tincture of aconite, and making 1 pint of the tincture.

Dose.—5 to 20 minims as an antiphlogistic. 20 to 30 minims in a single dose as a depressent; nausea and vomiting, and sometimes purging, follow this dose.

ASAGRÆA OFFICINALIS, *Lind.* Cevadilla.

Sabadilla, cevadilla, or cebadilla (from *cebada*, the Spanish for barley, from the resemblance of its flowering spike to an ear of barley), was known to Monardes in 1573. Its seeds, or rather fruits, have been occasionally employed for the destruction of vermin; they are now recognised as the source for obtaining the alkaloid veratria.

Characters.—Plants bulbous, cæspitose. *Leaves* linear, grass-like, tapering, smooth, channeled above, carinate below, 4 feet long, lax. *Scape* naked, 6 feet high, simple. *Raceme* very dense, 1½ foot long. *Flowers* polygamous, racemose, naked, yellowish-white. *Perianth* 6-partite, segments linear. *Stamens* alternately shorter; *anthers* cordate, after dehiscence shield-shaped. *Ovaries* 3, simple. *Stigma* obscure. *Follicles* 3, papery. *Seeds* scimitar-shaped, winged. Eastern side of the Mexican Andes.—*Nees von E. Suppl.* 4; *Bot. Reg.* vol. xxv. plate 33.

1. **Sabadilla**, *P.B.* *Cevadilla.*

The dried fruit of the plant above described. Imported from Mexico.

Characters.—Fruit about ½ inch long, consisting of three brown papyraceous follicles, each containing from 1 to 3 seeds, which are about ¼ inch long; blackish-brown, shining, slightly winged; possessing an intensely acrid, bitter taste, due to the alkaloid *veratria*, which is combined with *gallic acid*, and associated with a little *resin* and *fatty matter*.

2. **Veratria**, *P.B.* $C_{32}H_{52}N_2O_8$.

An alkaloid obtained from cevadilla: not quite pure.

Preparation.—Macerate 2 pounds of *cevadilla* with half its weight of *boiling water* in a covered vessel for twenty-four hours. Remove the cevadilla, squeeze it, and dry it thoroughly with a gentle heat. Beat it now in a mortar, and separate the seeds from the capsules by brisk agitation in a deep narrow vessel, or by winnowing it gently on a table with a sheet of paper. Grind the seeds in a coffee-mill, and form them into a thick paste with *rectified spirit*. Pack this firmly in a percolator, and pass *rectified spirit* through it till the spirit ceases to be coloured. Concentrate the spirituous solution by distillation so long as no deposit forms, and pour the residue, while hot, into twelve times its volume of *cold water*. Filter through calico, and wash the residue on the filter with water till the fluid ceases to precipitate with ammonia. To the united filtered liquids add the *solution of ammonia* in slight excess; collect the precipitate on a filter, and wash it with water till the fluid passes colourless. Diffuse the moist precipitate through 12 ounces of *water*, and add gradually, with diligent stirring, sufficient *hydrochloric acid* to make the fluid feebly but persistently acid. Then add 60 grains of *purified animal charcoal*, digest at a gentle heat for twenty minutes, filter, and allow the liquid to cool. Add *ammonia* in slight excess, collect the precipitate on a filter, and wash it with cold water till the washings cease to be affected by nitrate of silver acidulated with nitric acid. Lastly, dry the precipitate first by imbibition with filtering paper, and then by the application of a gentle heat.

The spirit dissolves gallate of veratria, resin, and colouring matter from the separated seeds. When the concentrated tincture is poured into 12 volumes of water, most of the resin is precipitated. Ammonia precipitates veratria, which is freed from most of the colouring matter by washing. The veratria, dissolved in acid, is further decolorised by the carbon, again precipitated by ammonia, washed, and dried.

Characters and Tests.—Pale grey, amorphous, odourless; but the minutest quantity produced intense irritation of the nostrils; strongly and persistently bitter, and highly acrid; insoluble in water; soluble in spirit, æther, and diluted acids, leaving traces of resin. Heated with access of air, it melts into a yellow liquid, and at length burns away without residue.

Action and Uses.—An active, violently irritant poison, unsuitable for subcutaneous use. $\frac{1}{20}$th of a grain usually produces great nausea, vomiting, and generally purging, at the same time reducing the force and frequency of the pulse. It has been used as a substitute for colchicum in gout and rheumatism. Externally applied, it is errhine and rubefacient. It may be applied in the following form:—

3. Unguentum Veratriæ, *P.B.* *Veratria Ointment.*

Contains 1 grain in 60.

Prepared by thoroughly mixing 8 grains of *veratria* first with $\frac{1}{2}$ fluid drachm of *olive oil*, and then with 1 ounce of *prepared lard.*

Use.—A stimulant in rheumatism and neuralgia. If used too freely, it may cause erythema, or even pustular inflammation of the skin. It is also useful for the destruction of pediculi.

LILIACEÆ, *Decand.* The Lily Family.

These plants are known from Melanthaceæ by their introrse anthers and the loculicidal dehiscence of the fruit. From Amaryllidaceæ by the superior ovary.

URGINEA SCILLA, *Steinheil.* The Squill.

The Squill (Σκίλλα) was employed by the ancient Greeks. The Asiatics substitute for it an allied species, *Urginea indica*, to which they apply the name of *Iskeel.*

Characters.—*Bulb* roundish-ovate, very large, half above ground; integuments greenish or reddish. *Leaves* all radicle, appearing after the flowers, spreading, fleshy, lanceolate, channeled, recurved. *Scape* from 2 to 4 feet high, rising from the centre of the leaves, simple, cylindrical, terminated by a long, dense, ovate raceme of flowers, with long bracts. *Flowers* pale yellowish-green. *Perianth* 6-parted, spreading. *Stamens* 6, shorter than the perianth; anthers yellow. *Ovary* 3 parted, with 3 nectariferous glands at the apex. *Style* smooth, simple. *Stigma* obscurely 3-lobed. *Capsule* rounded, 3-cornered, 3-celled. *Seeds* numerous, in 2 rows, flattened, winged, with a membranous testa. Native of both the north and the south sides of the Mediterranean and of the Levant. Flowers in August.—*Bot. Mag.* t. 918; *Nees von E.* 55; *St. and Ch.* 153; *Wood. Med. Bot.* pl. 118 (*Scilla maritima*).

1. **Scilla,** *P.B.* *Squill.*

The sliced and dried bulb, from the Mediterranean coasts.

Characters and Constituents.—Pear-shaped, weighing from ½ to 10 pounds; outer scales membranous, brownish-red or white; inner, thick, whitish, fleshy, juicy; taste mucilaginous, intensely bitter, and somewhat acrid.

The *dried slices* are white or yellowish white, bitter, slightly translucent, and horny, like Tragacanth. In a moist atmosphere, flexible. Many spiral vessels may be detected in these scales by the microscope, as well as numerous acicular raphides. Pulvis scillæ contains 9 or 10 per cent. of these crystals. This powder is apt to concrete and become resinous on keeping, apparently from a decomposition of some of its principles. Squill consists of water (about ⅘ths), with gum, uncrystallisable sugar, traces of tannin, phosphate of lime, lignin, and a bitter resinous extractive, from which a peculiar principle called *Scillitin* has been extracted. Observers differ as to the nature of this principle. Probably more than one body has been included under this name; for some have found it to be uncrystallisable, neutral in reaction, and resinous in appearance; others have obtained crystals, which are said to be capable of neutralising acids. Labourdais states that it assumes a fine purple tint in contact with sulphuric acid. Squill contains also, in its extractive, a peculiar resinous acrid principle, to which perhaps its properties are mainly owing. They may be extracted by alcohol and acetic acid.

Action. Uses.—An irritant. In small doses, expectorant and diuretic; and in larger, emetic and cathartic. Used in chronic catarrh, and in general dropsy, especially when there is a deficiency in tone. Its effects may be increased by combination with other diuretics and expectorants.

Dose.—1 to 3 grains as an expectorant or diuretic; 10 to 15 as an emetic.

Pharmaceutical Uses.—In the preparation of Pilula ipecacuanhæ cum scilla, and the six articles following:—

2. **Acetum Scillæ,** *P.B.* *Vinegar of Squill.*

Preparation.—Macerate 2½ ounces of *bruised squill* in 1 pint of *dilute acetic acid* for seven days; then strain and express; add 1½ fluid ounce of *proof spirit* to the strained liquor, and filter.

Dose.—15 to 40 minims. It may be given as oxymel (3) or syrup (4).

3. **Oxymel Scillæ,** *P.B.* *Oxymel of Squill.*

Preparation.—Mix 1 pint of *vinegar of squill* and 2 pounds of *clarified honey*, and evaporate by a water-bath until the product, when cold, has the sp. gr. 1·32.

Dose.—½ to 1 fluid drachm. A very useful expectorant both for children and adults.

4. **Syrupus Scillæ,** *P.B.* *Syrup of Squill.*

Preparation.—Dissolve by the aid of heat 2½ pounds of *refined sugar* in 1 pint of *vinegar of squill.*

Dose.—½ to 1 fluid drachm.

5. **Tinctura Scillæ,** *P.B.* *Tincture of Squill.*

Prepared by exhausting 2½ ounce of *bruised squill* with 1 pint of *proof spirit,* in the manner directed for Tinctura aconiti, making 1 pint of the tincture.

Dose.—10 to 30 minims. The only fluid preparation of squill free from acid.

6. **Pilula Scillæ composita,** *P.B.* *Compound Squill Pill.*

Preparation.—Mix 1¼ ounce of *squill* in powder and 1 ounce each of *ginger, ammoniacum,* and *hard soap,* all in powder. Add 2 ounces or a sufficiency of treacle, and beat into an uniform mass.

Dose.—5 to 10 grains as an expectorant in bronchitis.

ALOE, *Linn.* SPECIES VARIÆ. Aloe Plants.

Succulent plants, with spiked inflorescence. *Perianth* tubular, 6-cleft, sometimes so deeply divided as to appear 6-petaled, converging below into a tube, with the limb regular, spreading, or recurved, somewhat fleshy, nectariferous at the base; segments ligulate. *Stamens* hypogynous, ascending, as long as the tube, or projecting beyond it. *Style* as long or almost wanting, 3-furrowed. *Stigma* simple or triple, minute and replicate. *Capsule* membranous, scarious, obtusely or acutely triangular, 3-celled, 3-valved; valves bearing the septa in the middle. *Seeds* numerous, in two rows, flattened or three-cornered, winged or angled.

The word *aloe,* in our translation of the Bible, is confounded with *ahila,* or eagle-wood (see Ahalim, *Bibl. Cycl.*). Aloes were known to Dioscorides, to Galen, and to Celsus. The Arabs describe three kinds—Socotrine, Arabic, and Semegenic. The Indo-Persian writers give *Sibr* or *Sibbur* as its Arabic, *bol-seah* (black myrrh) as its Persian name. The Hindoo *elwa* is very similar to the word *aloe,* and the Greek *fekra,* which the Arabs quote, seems to be derived from πικρος.

The following species furnish the several kinds of aloes known in commerce. The Asiatic species, with those of Abyssinia and Socotra, are enumerated in Dr Royle's *Illustr. of Himal. Bot.* p. 389.

1. A. VULGARIS, *Lam.* *The yellow flowering Aloe.*—*Stem* woody, simple, short. *Leaves* curved, lanceolate, armed with hard distant reddish spines. *Scape* branched. *Spike* cylindrical, ovate. *Flowers* yellow, at first erect, spreading, afterwards pendulous.—*Steph. and Church.* pl. 109; *Nees von Esen,* pl. 50; *Rhude,* ii. t. 3.

2. A. VULGARIS *var.* ABYSSINICA, *Lam.*—Subcaulescent. *Leaves* long and lanceolate, rather erect, hard, of a deep-green colour; rather concave above; margin sinuato-dentate reddish, *flowers* greenish yellow.

3. A. SOCOTRINA, *Lam.* *The Socotrine Aloe* (fig. 65).—*Stem* shrubby, thick, dichotomous. *Leaves* amplexicaule, ensiform, greenish, incurved, concave from side to side, the margins wavy, with numerous small white spiny undulations. *Flowers* scarlet at the base, pale in the middle, green at the point.—*Nees von E.* 50; *Steph. and Church,* 110; *Woodv.* pl. 260.

4. A. ISPICATA, *Thunb.*—Caulescent. *Leaves* flat, ensiform, dentate. *Flowers* spiked, campanulate, horizontal.

"Ex hujus succo optima gummi resina aloes paratur: ex reliquis speciebus vilior."—*Linn. fil.* *Habitat.*—Cape of Good Hope. Many other species grow in South Africa.

5. ALOE INDICA, *Royle.*—A low plant, with spikes of red flowers, growing in dry barren places in N.W. India. This, if known to Roxburgh, was probably included by him in *A. perfoliata.*

6. ALOE RUBESECENS, *Dec.*—*Stem* suffruticose. *Leaves* amplexicaul, spreading, thorny at the margin. *Peduncle* compressed, branched. Branches sub-bracteate.—*Pl. grass.* t. 15. A native of Arabia.

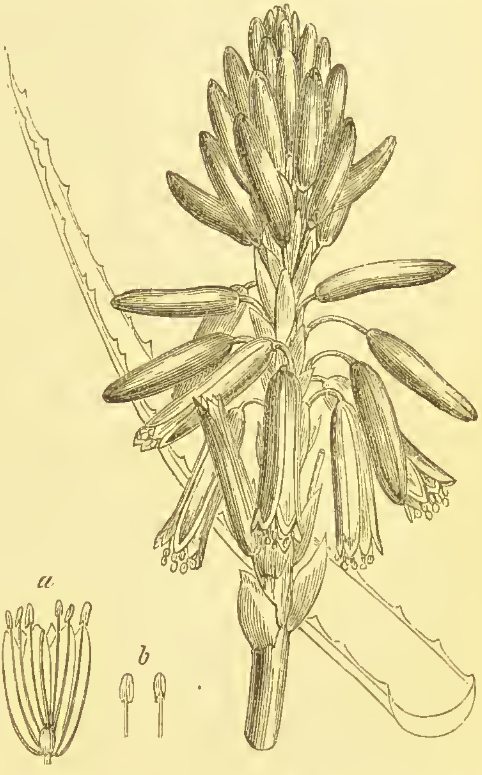

Fig. 65.—*Aloe socotrina.* *a, flower* opened; *b, stamens.*—*Woodv. Med. Bot.* pl. 260.

Aloes is the inspissated secretion contained in large greenish vessels lying parallel beneath the epidermis of the fleshy leaves. When they are broken across the juice exudes as a nearly colourless fluid, which quickly assumes a reddish-orange colour, and dries up, or rather crystallises into a brittle fragrant mass.

Extraction.—The leaves are removed by cutting or pulling, and thrown into tubs, where the juice is allowed to exude for twelve to twenty-four hours. It is then separated and either boiled down in copper vessels to the consistence of a hard extract, or exposed to the sun to dry and harden. The latter is the proper process, and yields a much finer product.

Composition.—Our knowledge of the constituents of aloes is mainly due to Messrs T. and H. Smith of Edinburgh, who have isolated a *volatile oil,* the essential purgative constituent crystalline *aloin,* and separated it from the so-called *resin.* Besides these, aloes contains a large proportion of *amorphous aloin, aloesic acid,* and a little *albumin.*

1. *The volatile oil* exists in very small quantity; Messrs Smith obtained 1 ounce only by the distillation of 400 pounds of aloes. It is a pale yellow mobile liquid, of sp. gr. 0·863; boils between 510° and 520°; has a minty taste and odour, and confers on aloes obtained by exudation and inspissation in the sun the agreeably fruity odour which it possesses.

2. *Aloin*, $C_{34}H_{36}O_{14},H_2O$ (Stenhouse).—This is the active constituent of aloes; it exists in two forms, the crystalline and amorphous, which together, and in nearly equal proportions, make up about 60 per cent. of good aloes. The crystalline variety, or aloin proper, as prepared by Messrs T. and H. Smith,* is a bright yellow powder, sparkling on account of its crystalline structure. It is a neutral substance of intensely and persistently bitter taste; the crystals are long, transparent, doubly refracting 4-sided prisms with dihedral extremities; soluble in 330 parts of cold water, freely soluble in æther and chloroform. Its solutions have at first a camboge-yellow colour, but quickly become deep red on exposure to the air. Nitric acid turns it this colour at once. With cold sulphuric acid it forms a dirty green solution. Paper soaked in the aqueous solution, and exposed to the vapours of peroxyde of nitrogen, is turned pink. At 212° aloin is rapidly changed; it melts at 302°, and when strongly heated burns, and leaves no residue. Treated with nitric acid it yields chrysammic and aloetic acids. Chrysammic acid, $HC_7H(NO_2)_2O_2$ (Mulder), is an explosive substance; its salts have a metallic lustre, and the acid itself furnishes with ammonia a purple solution and a crystalline salt resembling murexid. By the use of suitable mordants silk and woollen fabrics may be permanently dyed with the beautiful colours furnished by this substance.

Amorphous Aloin.—This probably bears the same relation to aloin that uncrystallised syrup does to cane sugar, and it is no doubt formed under similar conditions,—that is, the influence of vegetable acid and albumin, and the high temperature to which the juice is often subjected in the process of inspissation. Messrs Smith found that a solution of pure aloin undergoes this change when exposed to heat and evaporated, as in the process of recrystallisation. Dr W. Craig, however, has shown that it retains its purgative power unimpaired (*Edin. Med. Jour.* 1875). It exists in aloes in the proportion of 25 to 30 per cent. It is extremely soluble in water.

3. *Resin of Aloes.*—This name has been given to the substance which is deposited from a hot aqueous decoction of aloes. It is transparent, brown, soluble in alcohol, æther, and alkaline solutions. Aloes contains about 30 per cent. According to Messrs Smith, about $\frac{7}{8}$th is soluble in rectified spirit, and this yields 1 per cent of ash; the insoluble portion yields 23 per cent of ash. Tilden and Ram-

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* I am glad of this opportunity of acknowledging my obligations to these gentlemen for their liberality in furnishing me with materials for observation on this and other substances, and their readiness on all occasions to furnish me with information.

mell regard it as an incomplete anhydride. Dr Craig states (*op. cit.*) that, when thoroughly deprived of aloin, the so-called resin is inert; but my own observations do not support this statement; on the contrary, 2 grains of the pure resin sent to me by Messrs Smith and taken with 3 grains of soap, purged me freely, twelve and again sixteen hours after taking the dose. The same dose produced exactly the same result in another adult. In a third it had merely a laxative effect. The cathartic action of the resin is therefore far inferior to that of Barbaloin. In no case did it produce griping (see Appendix).

The quantities of the above-mentioned constituents varies with the kind of aloes, and is probably more dependent on the mode of preparation than on any other circumstance. Much of the aloes of commerce is prepared by boiling down the juice, and this would not only convert a portion of the aloin into the amorphous variety, but probably decompose another portion into the less active resin.

The varieties of aloin are now recognised as *Barbaloin*, *Socaloin*, and *Nataloin.* Histed thus distinguishes between them; a drop of nitric acid gives with the first and last a brilliant crimson, but produces little effect on socaloin. To distinguish between barbaloin and nataloin, mix each with a drop of sulphuric acid, and then pass over them a rod moistened with nitric acid, the former undergoes no change, but the latter develops a fine blue.

Action and Uses.—In small doses ($\frac{1}{4}$ of a grain) aloin is tonic, increasing the flow of the gastric, duodenal, and hepatic secretions, and stimulating the action of the muscular fibres of the alimentary canal, so promotes digestion. In larger doses (1 to 3 grains) it produces, in from twelve to twenty-four hours, free catharsis; and this is attended by increased activity of the abdominal circulation, and in many persons by active congestion of the pelvic viscera, resulting in hæmorrhoids and hæmorrhoidal or uterine discharges. Hence aloes have been regarded as emmenagogue from the earliest times. Its action is slower than most vegetable cathartics, but its cholagogue action is more marked than any, excepting perhaps podophyllin. The action of aloin is at least twice as strong as that of the best aloes, and this, according to Mr Finlay Dunn of the Edinburgh Veterinary College, is very marked in the horse. He states that 160 grains of aloin is equivalent to 8 drachms of crude aloes, and that it does not produce the nausea which usually accompanies the operation of the crude drug; and further, that horses physicked with aloin regain their appetite and are fit for work a day sooner than they are after an equal cathartic action produced by crude aloes. I have given aloin made into a pill, with an equal weight of hard soap, to a number of patients with the following results:—1. The cathartic action was uniform, rather more speedy than that of crude aloes, and unattended by griping. 2. The average dose for a strong adult male is about $1\frac{1}{2}$ grain, which usually causes two or three copious evacuations. $2\frac{1}{2}$ grains was always followed by powerful catharsis, producing five or six evacuations; and although some men could take this quantity for three or four nights in succession, it acted too powerfully upon others to allow of repetition until after an interval of a few days.

1. **Aloe Barbadensis,** *P.B.* *Barbadoes Aloes.*

The inspissated juice of the *Aloe vulgaris* imported from Barbadoes.

Characters.—In yellowish-brown or dark-brown opaque masses, which break with a dull conchoidal fracture. It has a bitter, nauseous taste, and a strong heavy disagreeable odour; dissolves almost entirely in proof spirit, and during solution exhibits under the microscope numerous crystals (of aloin). Usually imported in gourds.

Dose.—2 to 6 grains.

Pharmaceutical Uses.—The preparation of Enema aloes, Extractum aloes Barbadensis, Pilula aloes Barbadensis, P. aloes et ferri, P. cambogiæ composita, P. colocynthidis comp., P. colocynthidis et hyoscyami.

2. **Aloe Socotrina,** *P.B.* *Socotrine Aloes.*

The inspissated juice of the leaf of one or more undetermined species of aloe. Produced chiefly in Socotra, and shipped to Europe by way of Bombay.

Characters.—In reddish-brown masses, opaque, or translucent at the edges; breaks with an irregular or smooth and resinous fracture; has a bitter taste, and a strong but fragrant odour; dissolves entirely in proof spirit, and during solution exhibits under the microscope numerous minute crystals (of aloin).

Dose.—2 to 6 grains.

Pharmaceutical Uses.—An ingredient of the following:—Decoctum aloes compositum, Enema aloes, Extractum aloes Socotrinæ, E. colocynthidis compositum, Pilula aloes et assafœtidæ, P. aloes et myrrhæ, P. aloes Socotrinæ, P. rhei composita, Tinctura aloes, T. benzoini composita, Vinum aloes.

3. **Extractum Aloes Barbadensis,** *P.B.* *Extract of Barbadoes Aloes.*

Preparation.—Add 1 pound of *Barbadoes aloes* in small fragments to 1 gallon of *boiling water*, and stir well until they are thoroughly mixed. Set aside for twelve hours; then pour off the clear liquor, strain the remainder, and evaporate the mixed liquors by a water bath or a current of warm air to dryness.

By this process the greater portion of the aloin is removed, and separated from the inert resin, but the aloin is doubtless impaired by the process, for the resulting extract is in no way superior to the crude aloes. This and the following preparation originated in the notion that the resin was irritant and caused griping, but Dr F. Farre has shown that this is an erroneous supposition. He gave to about 60 patients, at different times for the relief of constipation, 3 grains of crude aloes, of extract of aloes, and of the resinous deposit from the decoction of aloes. The results were uniform. "The crude aloes and the extract produced from one to three alvine evacuations in twelve or eighteen hours. The crude drug did not gripe more than the extract; there was little difference in their action; perhaps the extract acted a little more speedily. The dried resinous deposit was almost inert."—(*Dr Farre's Edition of Pereira's Mat. Med.* p. 202.)

For the sake of simplicity, not to say scientific accuracy, it would be well if this and the following useless repetitions were removed from the Pharmacopœia, and the pure active constituents—aloin —prescribed in their stead.

Dose.—2 to 6 grains.

4. **Extractum Aloes Socotrinæ**, *P.B.* *Extract of Socotrine Aloes.*

Prepared as No. 3, and the same remarks are equally applicable to it.

Dose.—2 to 6 grains.

Pharmaceutical Preparations.—Decoctum aloes compositum and Extractum colocynthidis compositum.

5. **Enema Aloes**, *P.B.* *Enema of Aloes.*

Contains 4 grains of aloes in 1 fluid ounce.

Preparation.—Mix 40 grains of either *Barbadoes* or *Socotrine aloes* and 15 grains of *carbonate of potash* together, add 10 fluid ounces of *mucilage of starch*, and dissolve.

Use.—A purgative enema. From 2 to 4 ounces may be beneficially injected for the removal of thread and round worms from the bowels.

6. **Decoctum Aloes compositum**, *P.B.* *Compound Decoction of Aloes.*

Contains 4 grains of extract of Socotrine aloes in 1 fluid ounce.

Preparation.—Reduce 120 grains of *extract of* (*Socotrine*) *aloes* and 90 grains of *myrrh* to coarse powder, and put them, together with 60 grains of *carbonate of potash* and 1 ounce of *extract of liquorice*, into a suitable covered vessel with a pint of *water;* boil gently for five minutes, then add 90 grains of *saffron.* Let the vessel with its contents cool, then add 8 fluid ounces of *tincture of cardamom*, and covering the vessel closely, allow the ingredients to macerate for two hours; finally, strain through flannel, pouring as much water over the contents of the strainer as will make the strained product measure 30 fluid ounces. The boiling must not be prolonged beyond the time specified, otherwise a portion of the aloes will become insoluble.

At first this decoction is intensely bitter, but after the lapse of a few weeks, and owing to some change in the aloes, which however does not impair its efficacy, it entirely loses this quality.

Action and Uses.—A pleasant cathartic, and owing to the stimulant and tonic action on the abdominal circulation it is regarded as emmenagogue. In anæmia and the constipation which frequently attends it, the decoction may be given in combination with the Mistura ferri composita.

Doses.—$\frac{1}{2}$ to 2 fluid ounces.

7. **Tinctura Aloes,** *P.B.* *Tincture of Aloes.*

Contains 11 grains of Socotrine aloes in 1 fluid ounce.

Preparation.—Macerate ½ ounce of *Socotrine aloes* in coarse powder, and 1½ ounce of *extract of liquorice* in a sufficiency of *proof spirit* for seven days with occasional agitation; then filter, and add sufficient proof spirit to make 1 pint.

Like the other fluid preparations of aloes, it loses its bitterness by keeping.

Dose.—1 to 2 fluid drachms.

8. **Vinum Aloes,** *P.B.* *Wine of Aloes.*

Preparation.—Macerate 1½ ounce of *Socotrine aloes*, 80 grains each of *cardamom seeds bruised*, and *ginger in coarse powder*, with 2 pints of *sherry* for seven days, occasionally agitating, then filter, and add sufficient sherry to make 2 pints.

An ancient and superfluous preparation. It is always found "ripe" with age.

Dose.—1 to 2 fluid drachms.

9. **Pilula Aloes Barbadensis,** *P.B.* *Pill of Barbadoes Aloes.*

Preparation.—Beat together until they are thoroughly mixed 2 ounces of *Barbadoes aloes in powder*, 1 ounce of *hard soap*, 1 fluid drachm of *oil of caraway*, and 1 ounce of *confection of roses.*

Dose.—5 to 10 grains.

10. **Pilula Aloes Socotrinæ,** *P.B.* *Pill of Socotrine Aloes.*

Using Socotrine aloes, and substituting volatile oil of nutmeg for oil of caraway, prepare as No. 9, using the same quantities of the ingredients.

Dose.—5 to 10 grains.

11. **Pilula Aloes et ferri.**

(See p. 211).

12. **Pilula Aloes et Assafœtidæ,** *P.B.* *Aloes and Assafœtida Pill.*

Preparation.—Beat together until thoroughly mixed equal parts of *Socotrine aloes* in powder, *assafœtida, hard soap* in powder, and *confection of roses.*

Use.—In the constipation with flatulent distension attending hysteria and epilepsy.

Dose.—5 to 10 grains.

13. **Pilula Aloes et Myrrhæ,** *P.B.* *Aloes and Myrrh Pill.*

Preparation.—Triturate 2 ounces of *Socotrine aloes*, 1 ounce of *myrrh*, and ½ ounce of *dried saffron* together, and sift. Then add 1 ounce of *confection of roses*, and beat together into an uniform mass.

Use.—Purgative and emmenagogue in anæmia and chlorosis.

Dose.—5 to 15 grains.

Several other varieties of aloes besides those above described are found in commerce, the most common are the following:—

Liquid Socotrine Aloes has lately been imported from the coasts of the Red Sea. It yields a crystalline deposit on standing, and may be dried into a mass resembling the opaque Socotrine kind.

Hepatic Aloes, so called from its usual liver-brown colour, is imported into Bombay from Arabia and Africa, and is known in India by the name of Bombay aloes. Some of it, if not all, is probably obtained from the same sources as the Socotrine, which it resembles in odour: and, as Dr Pereira states, "the two are sometimes brought over intermixed, the Socotrine occasionally forming a vein in a cask of the hepatic aloes." It is of a liver-brown colour, has a dull, somewhat waxy fracture, and is less fragrant. The taste is nauseous and intensely bitter; the powder of a golden-yellow colour. This kind is inferior in quality to the fine Socotrine.

Cape Aloes is especially distinguished by its vitreous lustre, and is hence called *Aloe lucida* by some authors. The finer qualities are of a deep-brown colour externally, with a tinge of olive-green; thin laminæ are translucent, with something of a yellowish-red colour. It is very brittle, easily pulverised, its odour strong, rather disagreeable, and its powder of a yellow colour. Some of the inferior kinds are black, vesicular, and present a rough fracture. Some Cape aloes is yielded by *A. spicata*. Dr Pappe, in his "Cape Medical Flora," mentions several other species as yielding aloes in different parts of the colony. He states that *A. ferox*, Lam., a native of Swellendam, yields the best. Some from *A. Africana*, Mill, is exported in large quantities from the eastern districts. But the aloes commonly used at the Cape is that of *A. plicatilis*, Mill, which inhabits a mountain range near the Paarl.

Natal Aloes resembles hepatic aloes, being of a greyish-brown colour and opaque. It is prepared by boiling down the exuded juice. The aloin is less soluble than that of Barbadoes aloes. According to Tilden its composition is $C_{25}H_{28}O_{11}$.

Some inferior kinds of aloes are produced in *India*. Excellent aloes is said to be produced in *Cyprus*, but not in sufficient quantity to be exported. And lastly, a small quantity is yielded in the island of *Curaçoa*, in the Dutch West Indies.

SMILAX, *Linn.* SPECIES VARIÆ. Sarsaparilla.

Generic Characters.—Evergreen climbing *shrubs*. *Root* fibrous or tuberous. *Stems* often prickly. *Leaves* alternate, petiolate, cordate or hastate, reticulate-venose, cirrhiferous stipules between the petioles. *Flowers* sessile on a globular receptacle, subcapitate, pedicellate, or umbellate. Diœcious. *Perianth* 6-partite, nearly equal, spreading, in the female persistent. Stamens 6, inserted into its base. *Anthers* linear, erect. *Ovary* 3-celled. Cells 1-seeded. *Style* very short. *Stigmas* 3, spreading. *Berry* 1–3 seeded. *Seeds* subglobular. Albumen cartilaginous. *Embryo* very small, remote from the umbilicus.

The *Smilax aspera* of Greek authors continues to be employed in medicine. The name *sarsaparilla* (from the Spanish *sarsa*, a bramble, and *parilla*, a vine) is applied to species of the same genus, the roots of which were first introduced into Europe from the New World in the sixteenth century. Several kinds, as Jamaica, Honduras, Brazilian, &c., are known in commerce; but it is impossible at present to determine correctly the species which yield the several varieties of drug. Much of it is brought over by the Indians from the little-known Mosquito coast to Jamaica, and thence imported into this country: the greater portion of the remainder being imported from Mexico, Guatemala, Brazil, and Peru.

The following species furnish the greater portion of the sarsaparilla of commerce:—

1. S. OFFICINALIS, Humb. and Bonpl.—*Stem* prickly, quadrangular. *Leaves* ovate, oblong, cordate, coriaceous, 1 foot long and 4 or 5 inches broad.

Habitat.—Costa Rica, Columbia, and the south-eastern parts of Brazil.

The natives collect the roots on the banks of the Magdalena and take them to Cartagena, whence they are exported to Jamaica. According to Pohl, the roots are also collected in the western parts of the province of Minas Geraes. This species is the source of the Jamaica and Lima sarsaparillas, and of a portion at least of Brazilian.

2. S. PAPYRACEA, Poir.—*Stem* quadrangular, polished, prickly. *Leaves* membranous, ovate, oblong, obtuse, 5-ribbed. *Tendrils* attached near the middle of the petiole. *Fruit* baccate, the size of a pea.

Martius found that the roots of this plant were collected by the Indians on the Rio Negro, and other places in the vicinity of the Amazon river. The plant is also indigenous to Guatemala. It yields the Guatemala and most of the Brazilian sarsaparilla.

3. S. MEDICA, Schlecht.—*Stem* angular, prickly. *Leaves* acuminate, cordate, auriculo-hastate, 5-7 ribbed. *Inflorescence* umbellate. *Fruit* red, the size of a small cherry.—*Linnæa*, vi. 47.

Habitat.—The eastern slopes of the Mexican Andes.

This plant furnishes the Mexican, Vera Cruz or *lean* sarsaparilla.

Sarsaparilla roots are usually imported in bundles, formed of the roots folded up—or unfolded, as in the Brazilian variety—frequently still adhering to the *rhizome*. These roots are flexible, several feet in length, about the thickness of a quill, cylindical, but wrinkled longitudinally, with radicles attached along their length, of a reddish or yellowish brown colour. They are composed of a thick cellular cortex, covered by a thin epidermis; of the meditullium or duramen, an inner layer of ligneous intermixed with cellular tissue; and of a central pith often containing starch, in the interior. Hence a transverse section resembles one of an exogenous stem without medullary rays. Sarsaparilla is without odour, often with little else than a mucilaginous taste; but when good and fresh it is a little bitter, nauseous, and acrid,—a taste which affords, according to Dr Hancock, the best criterion of its goodness. The roots are often split up the middle and cut into short pieces, for the facility of making preparations.

The following are the different kinds of sarsaparilla of commerce:—Brazilian, Honduras, *gouty* Vera Cruz or Caracas; Guatemala, Lima, *lean* Vera Cruz, and Jamaica. The three last mentioned are free from starch; the rest are mealy or gouty from the deposit of starch, and this constitutes the main difference between the several kinds.

The non-mealy or lean kinds are preferred, and a rich reddish-brown colour, and some bitterness or acridity of taste, are accepted as the indications of a good drug.

1. **Sarsæ Radix**, *P.B. Jamaica Sarsaparilla.*

The dried root of *Smilax officinalis*, Humb. and Bonpl. Native of Central America, and imported from Jamaica.

Characters and Constituents.—Roots not thicker than a goose-quill, generally many feet in length, reddish-brown, covered with rootlets, and folded in bundles about 18 inches long, taste mucilaginous, feebly bitter, faintly acrid, and odourless. The essential constituents are, a little *volatile oil* heavier than water, of an acrid taste: it confers on the root its feeble acridity; and *smilacin*, a white crystalline neutral principle of a feebly bitter taste, very slightly soluble in cold, but to a greater extent in boiling water, forming a solution which froths like one of saponin. It is soluble in alcohol and æther, and may be obtained in crystals by evaporation of a hot concentrated tincture of the root.

Action and Use.—The experiments of Boeker on smilacin (*Journ. fur Pharmadyn. u. Toxicol.* ii. p. 50) bear out the conclusions which all close observers have arrived at respecting sarsaparilla, namely, that it is destitute of any appreciable physiological or therapeutical action. Those who believe they have witnessed good effects from its use derive it, I have noticed, from the use of the compound decoction, which contains three other drugs, each of which possesses some activity of its own; and the sudorific, stimulant, and purifying action ascribed to the decoction may fairly be attributed to these drugs, rather than to one which in any dose is incapable of developing any general or specific action in the body. Sarsaparilla has the reputation of purifying the blood, and especially of cleansing it of lingering syphilitic virus; and, in common with most other positively harmless remedies, it has been largely prescribed against chronic rheumatism and obstinate skin diseases, and generally at a time when more active remedies, such as iodide of potassium, have been employed. The decoction has a good body, and for a draught of physic an uncommonly good flavour. Patients like it and report well of it, and the doctor is favourably impressed. I have known syphilitic and scrofulous patients drink it freely and continuously for years, without being able to satisfy myself that it made any impression on their maladies.

2. **Decoctum Sarsæ**, *P.B. Decoction of Sarsaparilla.*

Preparation.—Digest 2½ ounces of *Jamaica sarsaparilla, cut transversely*, in 1½ pint of *boiling water* for an hour, then boil for ten minutes in a covered vessel, cool and strain, washing the root, if necessary, with a little water to make the product measure 1 pint.

Dose.—2 to 10 fluid ounces.

3. **Decoctum Sarsæ compositum**, *P.B.* *Compound Decoction of Sarsaparilla.*

Preparation.—Digest 2½ ounces *Jamaica sarsaparilla cut transversely*, ¼ ounce each of *sassafras root in chips*, *guaiacum wood turnings*, and *fresh liquorice root bruised*, and 60 grains of *mezereon bark* in 1½ pint of boiling water for an hour, and prepare 1 pint of the decoction in the manner directed for the simple decoction.

Dose—2 to 10 fluid ounces.

4. **Extractum Sarsæ liquidum**, *P.B.* *Liquid Extract of Sarsaparilla.*

Preparation.—Digest 1 pound of *sarsaparilla cut transversely*, in 7 pints of *water* at 160° for six hours, and decant the liquor. Digest the root again in 7 pints more hot water for the same time, express; filter the mixed liquors, and evaporate them by a water-bath to 7 fluid ounces, or until the sp. gr. is 1·13. When cold, add 1 fluid ounce of *rectified spirit.*

The sp. gr. should be about 1·095.

Dose.—2 to 4 fluid drachms.

GYMNOSPERMÆ, *Lindl.* Gymnosperms.

A division of Exogens, in which the ligneous tissue is dotted with disk-like marks, and the ovules are truly naked, so as to be fertilised directly through the foramen of the ovule.

The *Cycadaceæ* form a small family somewhat resembling diminutive palms; they are closely allied to Coniferæ.

A kind of sago is said to be procured from the cellular tissue of the stem of *Cycas revoluta*, a native of Japan, and also of *C. circinalis.* Both exude a clear insipid mucilage, which hardens into a firm transparent gum, like Tragacanth, but clearer.

Lindley states that one of the best kinds of arrowroot is prepared in the Bahamas from the trunk of some species of Zamia.

CONIFERÆ, *Juss.* Conifers.

The numerous medicinal products of Coniferous plants are obtained from the four genera,—Pinus, Abies, Larix, and Juniperus. We will take the products as they are furnished by the genera in this order.

PINUS, *Linn.* SPECIES VARIÆ. Pine Trees.

Generic Characters.—*Flowers* monœcious. *Males—Catkins* racemose. *Filaments* short. *Anthers* crested, 2-celled, bursting longitudinally (or stamens 2, anthers 1-celled). *Females—Catkins* solitary, or from 2 to 3. *Scales* imbricated, with membranous bractlets. *Ovules* 2, at the base of the scales, collateral, inverted, their points lacerated and directed downwards. *Scales* of the cone hard, woody, and truncated, hollowed at the base for the reception of the seeds. *Seeds* prolonged at the base into a membranous wing. *Leaves* evergreen, usually acicular, in fasicles, surrounded at the base by a membranous tubular sheath.

1. P. SYLVESTRIS, Linn., *Scotch Fir.*—*Leaves* in pairs. Young *cones* stalked, recurved, ovate-conical. *Wing* thrice as long as the seed.—*Lamb. Pin.* t. 1; *Nees von E.* t. 79.

Habitat.—Scotland, Norway, woods of Europe north of the Alps.

This species furnishes *red deal;* much *turpentine*, although very little of it is imported into this country; and is the chief source of *wood tar.*

There are two kinds of wood tar,—one is the product of the destructive distillation of exogenous wood generally (such as oak, ash, and birch), in the preparation of pyroligneous acid and gunpowder charcoal (see p. 351); the other is the produce of fir wood exclusively, and obtained by a process of roasting, or *distillatio per descensum*, described at p. 358.

Pix liquida, *P.B.* *Tar.* (See p. 358.)

TURPENTINES.

The following species yield turpentine:—

2. P. PALUSTRIS, Miller, *the Swamp* or *Long-Leaved Pine.*—A large tree, 60 to 70 feet high. *Leaves* in bundles of 3, about 1 foot long, and of a brilliant green. *Stipules* pinnatifid, ragged, persistent. *Cones* very long, subcylindrical, armed with sharp prickles.—*Lambert Pinus*, vol. i. pl. 20. *Habitat*, sandy soil from the southern parts of Virginia to the Gulf of Mexico.

According to Wood and Bache, this tree furnishes the greater portion of the turpentine and tar consumed in the United States or exported from it.

3. P. TÆDA, Linn., *the Frankincense Pine.*—Larger than the foregoing. *Leaves* also in threes, but rigid, and in long sheaths. *Cones* pyramidal, 3 to 4 inches long. *Scales* with short recurved prickles.—*Lamb.* vol. 1 pl. 16. *Habitat*, the United States.

4. P. MARITIMA, Dec. (*P. pinaster*, Aiton), *the Cluster Pine.*—This is also a large tree. *Leaves* twin, very long, rigid, with a reflexed scale at the base. *Cones* conical, obtuse, smooth, and bright. *Scales* bristly.—*Lamb.* vol. i. pls. 9 and 10. *Habitat*, shores of Southern Europe, abundant between Bordeaux and Bayonne. Its products are known as *Bordeaux turpentine and tar.*

5. P. PINEA, Lamb., and P. CEMBRA (*the Siberian Stone Pine*) are interesting, as the seeds of both, sometimes called *pine nuts*, are eaten, as are those of *P. Geradiana*, in Affghanistan and Thibet. *P. longifolia*, Lamb., is a Himalayan species, which yields a very fine turpentine, resembling pure white granular honey; much used by the natives of India in medicine, and called *bireeja*, &c.

These trees, in common with others of the order, secrete a large quantity of oleo-resin which exudes as a varnish or in granular masses from cracks in the bark. The following are the several kinds:—

1. **Thus Americanum**, *P.B.* *Common Frankincense.*

The concrete turpentine of *P. Tæda*, the frankincense pine, and *P. palustris*, the swamp pine. From the Southern States of North America. It is the spontaneous exudation from the natural fissures in the bark, portions of which are sometimes found in the drug.

Characters.—A softish bright yellow opaque solid, softening at the natural temperature of the body, resinous but tough, having the odour of American turpentine.

Pharmaceutical Use.—An ingredient of Emplastrum picis.

2. Bordeaux Turpentine. *French Turpentine.*

The produce of *P. pinaster*, which grows abundantly in the Landes, obtained by incision, and is imported from Bordeaux, Dax, and Bayonne. It is whitish, turbid, and separates upon standing into a transparent liquid and into a granular honey-like semifluid. It has an acrid and nauseous taste, a disagreeable smell, and yields about 20 per cent. of oil. M. Faure discovered that it is solidified by a 32d of its weight of magnesia.

Both the oil and resin are of inferior quality to those of American turpentine; the odour of the former is less grateful, and often has a *left*-handed rotatory power on polarised light. The resin is white, and is called *galipot;* it is chiefly composed of *pimaric acid.*

3. Common Turpentine. *American Turpentine. Horse Turpentine.*

The produce of all three species of pines above described, but chiefly *P. palustris*. Imported from America.

It is obtained by cutting a hollow in the trunk of the tree a few inches above the ground, and removing the bark for the distance of 18 inches above it. The turpentine runs down from the wounded edges of the bark and collects in the excavation, from which it is transferred to casks, and is commonly known as *horse turpentine.* It is a yellowish-white, soft, very adhesive resinous mass, resembling semisolid honey in appearance, of turpentine odour, and a warm aromatic bitter taste. It is composed of 14 to 16 per cent. of volatile oil, and 82 to 86 per cent. of resin.

OLEUM TEREBINTHINÆ, *P.B.* $C_{10}H_{16}$. Oil of Turpentine.

Essence or *Spirit of Turpentine.*

The oil distilled from the oleo-resin (turpentine), obtained from *P. palustris*, Miller's Dict., *P. Tæda*, Linn., and sometimes *P. pinaster*, Aiton.

Preparation.—The volatile oil is separated by distilling the crude turpentine with water in a copper still over a naked fire.

Characters.—Limpid, colourless, very inflammable liquid; sp. gr. 0·864, of its vapour 4·76; of a powerful terebinthinate odour, and a pungent, bitterish taste; shaken with water a minute quantity dissolves, and the solution has no action on blue litmus paper. Soluble in about 7 parts of rectified spirit; miscible in all proportions with alcohol, æther, and benzol. It dissolves the volatile and fixed oils and resins, forming with the latter varnishes. It is one of the best solvents for caoutchouc, sulphur, and phosphorus.

It forms with water three definite hydrates, *terpinol*, $(C_{10}H_{16})_2H_2O$, *terpine*, $C_{10}H_{16},2H_2O$, and *terpine hydrate*, $C_{10}H_{16},3H_2O$. The latter is deposited in large rhombic crystals, when a mixture of 4 vols. of oil of turpentine, 1 of nitric acid of sp. gr. 1·36, and 3 of alcohol, are exposed to the sunlight for a few weeks. Oil of turpentine forms two crystalline compounds with hydrochloric acid, $C_{10}H_{16},HCl$ and $C_{10}H_{16},2HCl$. These are called *artificial camphors.* The latter of the two has an odour resembling oil of thyme, and separates in rectangular prisms when oil of turpentine is left in contact with hydrochloric acid for some weeks. Exposed to the air, oil of turpentine gradually absorbs oxygen and is converted into resin; exposed to moist oxygen in the direct sunlight, the vapour is oxydised and condenses upon the surface of the jar in brilliant crystals of *hydrated oxyde*, $C_{10}H_{16}O,H_2O$. By the agency of stronger oxydising agents, *e.g.*, distillation with dichromate of potash and sulphuric acid, oil of turpentine is converted into formic acid. Nitric acid acts upon it so violently as often to inflame it; it converts it into resin, oxalic, terebic, and other acids.

Action and Uses.—Turpentine absorbed into the blood acts as a general stimulant to the circulation; it is eliminated by the skin, mucous membrane, and the kidneys, producing increase of the natural secretion of these organs; it is diaphoretic, expectorant, emmenagogue, diuretic, and topically stimulant to the gastric and urinary mucous membrane. Under its influence the urine assumes the odour of violets. When taken in large doses it usually passes off by the bowels, producing free evacuations, or failing this, it causes inebriation and strangury. In a relaxed state of the blood-vessels its action is tonic, promoting contraction, and so arresting hæmorrhage.

Turpentine is chiefly employed internally as an *anthelmintic* and *hæmostatic.* It is a most effectual remedy for tapeworm, for it kills the parasite before it expels it, which is more than can be said of male fern. The only objection against its use is the possibility of its producing strangury; but this may be obviated by combining with it an efficient dose of castor oil. It may also be given combined with castor oil as an enema for the removal of ascarides. As a hæmostatic it is appropriately used in enteric fever and dysentery, and especially when there is tympanites. For the relief of the latter condition it is best given as an enema. In *cystitis* and *gleet* it may be given instead of copaiba, if a more stimulant action be needed. It is sometimes prescribed as a *diuretic* in pulmonary, hepatic, and cardiac dropsy, but we must be sure that the kidneys are healthy before we prescribe it in this condition.

It has also been employed as a vascular stimulant and diaphoretic in chronic rheumatism; but for the relief of rheumatic pain, and as a cutaneous stimulant, it is commonly used externally in the form of liniment or stupe.

Dose.—As a diuretic or hæmostatic, 5 to 20 minims on a teaspoonful of powdered sugar, with 1 or 2 ounces of chloroform water, or as the following confection. As an anthelmintic, from ½ to 2 fluid ounces mixed with 4 or 6 drachms of castor oil. As a stupe for the relief of abdominal pain or distension, ½ an ounce sprinkled over a hot flannel.

1. **Confectio Terebinthinæ**, *P.B.* *Confection of Turpentine.*

Preparation.—Rub 1 fluid ounce of *oil of turpentine* and 1 ounce of powdered *liquorice root* together, then add 2 ounces of *clarified honey*, and mix to an uniform consistence.

Dose.—60 to 120 grains.

2. **Enema Terebinthinæ**, *P.B.* *Enema of Turpentine.*

A mixture of 1 fluid ounce of *oil of turpentine* and 15 fluid ounces of *mucilage of starch.* Useful in constipation with colic; in tympanites and the flatulent distension which sometimes accompanies epilepsy and hysteria; and as an anthelmintic.

3. **Linimentum Terebinthinæ**, *P.B.* *Liniment of Turpentine.*

Preparation.—Dissolve 1 ounce of *camphor* in 16 fluid ounces of *oil of turpentine*, then add 2 ounces of *soft soap*, and rub them together until they are thoroughly mixed. A strong cutaneous stimulant in rheumatism, stiff joints, and neuralgic pains. It has been recommended as dressing to recent scalds and burns, on the principle I assume of "*similia similibus curantur*," but this is rather too direct an application of this doctrine to be either grateful to the feelings or beneficial to the condition of the patient. Soothing applications are more appropriate for recent burns.

4. **Linimentum Terebinthinæ aceticum**, *P.B.* *Acetic Liniment of Turpentine.*

A mixture of equal volumes of *oil of turpentine*, *acetic acid*, and *liniment of camphor.*

A very powerful counter-irritant, to be used with caution on the lower extremities or it may excite too much action.

5. **Unguentum Terebinthinæ**, *P.B.* *Turpentine Ointment.*

Preparation.—Melt together 1 fluid ounce of *oil of turpentine*, 60 grains of *resin* in coarse powder, and ½ an ounce each of *yellow wax* and *prepared lard*, by the heat of a steam or water bath, and stir the mixture constantly while it cools.

A stimulant ointment to pallid or congested excoriations and ulcerations.

RESINA, *P.B.* Resin. *Rosin.* *Colophony.*

The residue of the distillation of the several kinds of turpentine, but chiefly of American turpentine.

Characters and Composition.—Translucent, yellowish or amber-coloured, brittle, pulverisable, fracture shining; odour and taste faintly terebinthinate; easily fusible, and burns with a dense yellow flame and much smoke. Turpentine yields from 75 to 90 per cent. of resin. It is chiefly composed of *pinic acid*, $HC_{20}H_{29}O_2$, an amorphous resin soluble in cold rectified spirit; of a little *neutral resin*, and *sylvic acid* isomeric with pinic acid, and separating from solution in hot alcohol in colourless rhombic prisms fusible at 260°6. The æthereal solution decomposes the carbonates of the alkaline metals, and the acid forms a crystalline compound with plumbic oxyde. Resin is soluble in the caustic alkalies, and forms a large constituent of yellow soap. Boiled with nitric acid, it is oxydised and dissolved, forming *terebic acid*, $HC_7H_9O_4$, which separates in

4-sided prisms with oblique extremities, soluble in cold but very freely in boiling water, and in alcohol and æther.

Action and Uses.—Resin possesses the valuable quality of adhesiveness, and it is also slightly stimulant. These qualities are available in Charta epispastica, Emplastrum calefaciens, E. cantharidis, E. hydrargyri, E. picis, E. saponis, Unguentum terebinthinæ, and the following:—

1. **Emplastrum Resinæ**, *P.B.* *Resin Plaster.*

Preparation.—To 2 pounds of *lead plaster* previously melted with a gentle heat, add 4 ounces of *resin* and 2 ounces of *hard soap*, first liquefied, and stir them until they are thoroughly mixed.

The resin is used to give increased adhesiveness to the lead plaster.

Pharmaceutical Uses.—A large constituent of the following plasters:—Emplastrum belladonnæ, E. calefaciens, E. opii, and E. plumbi iodidi.

2. **Unguentum Resinæ**, *P.B.* *Resin Ointment* (*Yellow Basilicon*).

Preparation.—Melt together 8 ounces of *resin* in coarse powder, 4 ounces of *yellow wax*, and 16 ounces of *simple ointment*, with a gentle heat; strain while hot through flannel, and stir constantly while it cools.

Action and Uses.—A mild stimulant application to promote healthy discharge from excoriated or ulcerated surfaces.

ABIES, *Tourn.* SPECIES VARIÆ. Fir-trees.

Generic Characters.—Monœcious. *Males — Catkins* solitary. *Anthers* bursting transversely. *Females*—Catkins simple. *Scales* (or *carpels*) imbricated, thin at the apex, rounded, flat, instead of being hollowed for the seeds; when ripe, falling from the axis. *Leaves* solitary in each sheath, never fascicled. In other respects agreeing with Pinus.

1. A. EXCELSA, Decand., *Norway Spruce Fir*, a lofty tree, sometimes 150 feet high.—*Leaves* scattered, tetragonal. *Cones* cylindrical, pendulous; the *scales* rhomboidal, flattened, jagged, and bent backwards at the margin.—Northern parts of Eastern Europe, Alps, northern parts of Asia and America. —*Nees von E.* t. 80; *Woodv.* plate 208; (*Pinus Abies*). Yields "*abietis resina.*"

2. A. PICEA, Lindl., the *Silver Fir*, with distichous leaves and erect cones. A native of the mountains of Central Europe. Yields Strassburg turpentine.

3. A. BALSAMEA, Marsh, *Balm of Gilead Fir.*—*Leaves* solitary, flat subpectinate, suberect above. Acuminate apex of the scales of the *cone* reflexed when in flower. *Habitat.*—Northern parts of North America. Yields Canada balsam.—*Lamb. Pin.* t. 4; (*Pinus balsamea*, Linn.); *Nees von E.* t. 82.

4. A. CANADENSIS, Lindl., *Hemlock Spruce Fir*, is said to exude a turpentine similar to that of the foregoing. A. NIGRA, the *Black Spruce Fir*, is interesting as yielding the essence of spruce.

These species yield the following varieties of turpentine:—

1. **Pix Burgundica**, *P.B.* *Burgundy Pitch.*

A resinous exudation from the stem of *Abies excelsa*, melted in hot water and strained through a cloth. Imported from Switzerland. (According to Dr Flückiger of Berne, this resin is not collected in Switzerland, but is obtained from Finland and Austria.)

Characters.—Hard and brittle, yet gradually taking the form of the vessel in which it is kept; opaque, varying in colour, but generally dull reddish-brown; of a peculiar, somewhat empyreumatic perfumed odour and aromatic taste, without bitterness; free from air vesicles; gives off no water when heated. Soluble, excepting a little flocculent residue, in rectified spirit and glacial acetic acid. It is chiefly composed of resin, having the composition given above, most of the volatile oil being removed in the process of clarification.

Adulterations.—According to Pereira, the Burgundy pitch met with in this country is almost always a fictitious article, being composed of a mixture of resin, American turpentine, and palm oil.

Action and Uses.—Those of resin.

Pharmaceutical Uses.—A constituent of Emplastrum ferri and of the following:—

Emplastrum Picis, *P.B. Burgundy Pitch Plaster.*

Preparation.—Add 1 ounce of *expressed oil of nutmeg* and 2 ounces each of *olive oil* and *water* to 26 ounces of *Burgundy pitch*, 13 ounces of *common frankincense*, and 4½ ounces each of *resin* and *yellow wax*, melted together; then constantly stirring evaporate to a proper consistence.

Action and Uses.—A warming stimulant plaster, employed for protecting the chest and loins against cold.

2. **Terebinthina Canadensis**, *P.B. Canada Balsam.*

The turpentine obtained by incision of the stem of *A. balsamea.* From Canada.

Characters.—A pale yellow ductile oleo-resin, of the consistence of thin honey, with a very agreeable balsamic and terebinthine odour, and a slightly bitter, feebly acrid taste. On exposure drying very slowly into a transparent adhesive varnish, solidifying when mixed with $\frac{1}{6}$th of its weight of magnesia. It is composed of about 18·6 of volatile oil and 81·4 of resin.

Action and Uses.—Those of turpentine or its oil, than which it is milder and more agreeable. It is frequently prescribed as a pill or bolus with liquorice powder, in gleet, leucorrhœa, cystitis, and bronchorrhœa, and in chronic rheumatism. It is much used as a menstruum for microscopical objects and as a cement.

Pharmaceutical Uses.—A constituent of Charta epispastica and Collodium flexile.

3. **Strassburg Turpentine.**

This is obtained in the vicinity of the Alps by puncturing the bark of *A. Picea*, collecting the secretion in a bottle, and subsequently filtering it. It is quite fluid and transparent, of a yellowish colour, and very pleasant citron odour. It contains a large proportion of volatile oil.

An infusion of the fresh leaves of the silver pine is an excellent diuretic in chronic cardiac or pulmonary dropsy.

LARIX EUROPŒA, *Decand.* The Common Larch.

A native of Central Europe, commonly cultivated in Britain.

Characters.—50 to 60 feet high. *Leaves* fascicled, deciduous. *Male flowers*—*Catkins* solitary; *Stamens* 2; *Anthers* 1-celled. *Females*—*Ovules* 2 at the base of each scale. *Cones* ovate. *Scales* imbricated, with reflexed lacerated margins.

1. **Laricis Cortex,** *P.B. Larch Bark.*

The bark of the species above described, deprived of its outer layer. It contains turpentine, tannic acid, sugar, and gum. It is employed in the following preparation:—

2. **Tinctura Laricis,** *P.B. Tincture of Larch.*

Exhaust 2½ ounces of *larch bark* in coarse powder with 1 pint of *rectified spirit*, and obtain 1 pint of the tincture, in the manner prescribed for tincture of aconite.

Action and Uses.—Those of turpentine, but more astringent, on account of the presence of tannic acid, which renders this preparation more efficacious than mere turpentine as a hæmostatic and general astringent.

3. **Terebinthina Veneta.** *Venice* or *Larch Turpentine.*

Obtained by boring the trunk of the larch, collecting, and filtering. It is imported from Switzerland and Italy.

Characters.—A thick yellowish or greenish-yellow fluid, of the consistence of honey, transparent or cloudy; odour not so agreeable as the other turpentines; taste acrid, and very bitter. It does not concrete on keeping, a quality which distinguishes it from the other turpentines. According to Pereira, that sold in London is factitious, being a mixture of oil of turpentine and resin.

Action and Uses.—Those of Canada balsam.

JUNIPERUS. Juniper Shrubs.

Generic Characters.—Diœcious, rarely monœcious. *Males*—*Catkins* axillary or subterminal, ovate, small; *Anthers* 4-7, 1-celled, inserted on the lower edge of the subpeltate scales. *Females*—*Flowers* few, in an axillary ovate catkin, imbricated, with bracts at the base; lower ones barren. *Scales* 3-6, united at the base, and containing usually 3 *ovules*, which are erect, perforated at the apex. *Fruit*, consisting of the scales become succulent and consolidated into a drupe-like body, a *galbulus*. *Seeds* osseous, triquetrous.

JUNIPERUS COMMUNIS, *Linn.* Common Juniper.

The Juniper (ἄρκευθος) was employed by the Greeks, and subsequently by the Arabs, being their *abhool*. Species are mentioned in the Bible (see *Bibl. Cycl.*).

Characters.—A bushy *shrub*. Branches smooth and angular towards their extremities. *Leaves* evergreen, 3 in each whorl, spreading, linear, subulate, channeled, stiff and sharp-pointed, longer than the fruit, of a shining green colour on their lower surface, but having a broad glaucous line along the centre of the upper, which is resupinate. *Flowers* axillary, sessile, the males discharging much yellow pollen. *Females* on a separate shrub, green, on scaly stalks. The *fruit* ripens in the autumn of the second year.—A native of the northern parts of Europe, Asia, and America.—*Nees von E.* 86; *Woodv. Med. Bot.* plate 95.

All parts of this plant when bruised exhale a more or less agreeable terebinthine odour. The wood is officinal on the Continent; the tops and fruits are used in this country. The latter are imported from the north, but the best come from the south of Europe. They are globular, marked with three radiating furrows at the summit and below by the bracts; are of a purple-black colour, with a glaucous bloom, and contain a brownish-yellow pulp. Their taste is sweetish, followed by bitterness, slightly terebinthinate, as is the odour, and somewhat aromatic. These properties are imparted slowly to water and readily to alcohol. They depend on the presence of *volatile oil* 1 per cent., *wax* 4, *resin* 10, *gum* 7, *grape sugar* with *salts of lime*, 33·8, the remainder being lignin and water.

Action. Uses.—These berries are stimulant, diuretic. They are largely employed in the manufacture of Hollands gin.

1. **Oleum Juniperi,** *P.B.* $C_{10}H_{16}$. *Oil of Juniper.*

The oil distilled in Britain from the unripe fruit.

Characters.—It is colourless, or of a light green tinge; sp. gr. 0·839. Isomeric with oil of turpentine, and like it, little soluble in alcohol. It has the odour of the fruit, and a warm aromatic taste.

Action. Uses.—Stimulant, diuretic. It is considered very certain in its effects in doses of 4 to 6 minims. It is usually combined with spirit of nitrous æther and digitalis. Hollands gin owes its diuretic properties to the presence of this oil

2. **Spiritus Juniperi,** *P.B.* *Spirit of Juniper.*

A mixture of 1 fluid ounce of *oil of juniper* and 49 fluid ounces of *rectified spirit* = 1 vol. of the oil in 50.

Dose.—½ to 1 fluid drachm.

Pharmaceutical Use.—A constituent of Mistura kreasoti.

JUNIPERUS SABINA, *Linn.* Savin.

Savin is the *βϱαθυς* of Dioscorides, converted by the Arabs into *buratee.*

Characters.—A small, bushy, very compact *shrub,* disposed to spread. *Branches* slender, completely invested by the short, imbricating leaves. *Leaves* small, ovate, convex, opposite, decussate, deeply imbricated. *Fruit* round, of a bluish purple, about the size of a currant.—A native of the midland parts of Europe, of the mountains of the south of Europe, and of Russia in Asia.—*Nees von E.* 87; *Woodv. Med. Bot.* plate 94.

1. **Sabinæ Cacumina,** *P.B.* *Savin Tops.*

The fresh and dried tops of the above described plant, collected in spring from plants cultivated in Britain.

The plant when bruised exhales a heavy, very disagreeable odour.

Characters and Constituents.—Twigs, densely covered with minute, imbricated, adpressed leaves in four rows; odour strong and disagreeable; taste acrid, bitter, resinous, and nauseous. The woody portion of the twigs present the circular disc characteristic of coniferous wood. This, together with the imbricated, scale-like leaves, would be almost conclusive of the presence of savin. The essential constituent is *volatile oil* (see Oil of savin). It also contains resin and gallic acid.

Action and Uses.—A powerful irritant poison in large doses, producing gastro-enteritis, collapse, and death; externally it is rubefacient and vesicant. In medicinal doses it is stimulant, diuretic, and emmenagogue. Its emmenagogue action is very decided, so much so that it rivals ergot as an abortifacient; but on account of its violent irritant action it cannot be employed medicinally for this purpose, and when used criminally it has usually caused the death both of mother and child.

Dose.—Of the powder, 5 to 15 grains; but the oil is to be preferred.

2. **Oleum Sabinæ**, *P.B.* $C_{10}H_{16}$. *Oil of Savin.*

The oil distilled in Britain from fresh savin. The distillation is effected with water, and the yield of oil is about 3 per cent.

Characters.—Colourless or pale yellow; sp. gr. 0·915; of the characteristic and persistent odour of the plant; taste acrid and bitter; moderately soluble in rectified spirit, freely in æther.

Dose.—1 to 5 minims, as an emmenagogue, in the form of emulsion.

3. **Tinctura Sabinæ**, *P.B.* *Tincture of Savin.*

Prepared by exhausting 2½ ounces of *savin tops*, dried and coarsely powdered, by *proof spirit*, and obtaining 1 pint of the tincture, in the manner directed for tincture of aconite.

This is a very useless preparation, since the oil is the essence of the plant, and the quantity contained in a given weight of the dried tops is necessarily variable.

Dose.—From 20 to 60 minims.

4. **Unguentum Sabinæ**, *P.B.* *Savin Ointment.*

Preparation.—Melt 16 ounces of *prepared lard* and 3 ounces of *yellow wax* together in a water bath; add 8 ounces of *fresh savin tops*, and digest for twenty minutes. Then remove the mixture and strain through calico.

The ointment is of a light-green colour, and has the strong odour of savin.

Action and Use.—A strong stimulant application, usually employed to dress blisters when it is desired to keep them from healing too rapidly, and to promote discharges from issues and setons.

JUNIPERUS OXYCEDRUS. *The Brown Berried Juniper.*

By the dry distillation of the wood of this shrub, a tar called *huile de cade*, or *empyreumatic oil of juniper*, is obtained.

Oil of cade (oleum cadinum) is a brown inflammable tarry liquid, with a strong acrid taste. It is employed externally against parasite skin diseases in man and the domestic animals. It may be used in the proportion of 1 part to 2 of lard or spirit, and used as an ointment or lotion.

ALTINGIACEÆ, *Lind.* Liquidambars.

This is an order of Amental Exogens allied to the Planes (Platanaceæ). It contains but three species, and the following plant is the type of the order.

LIQUIDAMBAR ORIENTALE, *Miller.* The Storax Tree.

A tree resembling the plane (*Platanus orientale*), 20 to 60 feet high. A native of the south-west districts of Asia Minor, where it grows freely.

Characters.—Leaves palmi-lobed 5-cleft, irregularly serrate. *Flowers* unisexual. *Females* in globular catkins. *Ovary* of two carpels, 2-celled. *Styles* two. Fruit 2-celled. Many seeds. *Seeds* winged, albuminous. *Cotyledons* leafy.—*Miller's Dict.; Pharm. Journ.* vol. xvi. p. 462.

Production.—The inner bark of the tree is boiled in water, by which most of the balsam is separated. It is then packed in horse-hair bags, and strongly pressed in a wooden press; hot water is then thrown on the bags, and the pressure is renewed as long as any balsam can be obtained. Thus obtained it is taken to Smyrna, and shipped chiefly to Trieste. It is semifluid, opaque, grey, of a very grateful vanilla-like odour. It is often adulterated with sand or sawdust.

1. **Styrax præparatus**, *P.B.* *Prepared Storax.*

A balsam obtained from the bark of the tree above described; purified by means of rectified spirit, and straining.

Characters and Constituents.—A semi-transparent, brownish-yellow semi-fluid resin of the consistence of thick honey, with a strong, agreeable fragrance, and aromatic bland taste. Heated in a test tube on the vapour bath, it becomes more liquid, but gives off no moisture; boiled with a solution of bichromate of potash and sulphuric acid, it evolves the odour of hydride of benzoyl (essence of bitter almonds). According to Simon, storax consists of a *volatile oil (styrol), cinnamic acid, styracin,* and *resin.*

Styrol, C_8H_8, is an inflammable, very volatile transparent liquid, of sp. gr. 0·924, boils at 295°, has a burning taste, and aromatic odour resembling benzol and napthalin. It is soluble in alcohol and æther. At 401° it is converted into a polymeric *solid metastyrol*, destitute of taste and smell, and resolvable into styrol on the application of sufficient heat.

Styracin, $C_{18}H_{16}O_2$, is a crystallisable solid, polymeric with hydride of cinnamyl, fuses at 111°, is freely soluble in alcohol and æther, and when treated with potash is resolved into cinnamic acid, and styrone or cinnamic alcohol, HO,C_9H_9O. Oxydising agents (see action of bichromate of potash and sulphuric acid on storax) liberates hydride of benzoyl from this body. Thus it appears that storax is a member of the cinnamic series.

Impurities.—Storax is mixed up, both in the Levant and at Marseilles (Merat and De Lens), with the powdered bark or sawdust, and formed into flat cakes of "solid storax." These are brownish, and after a time become covered with a white mould-like efflorescence of cinnamic acid.

Action and Uses.—Storax agrees in these with the balsams of Tolu, Peru, and benzoin, which it so closely resembles in its chemical relations. It is chiefly used as a stimulant expectorant in chronic bronchitis.

Dose.—10 to 20 grains, as a bolus with liquorice powder.

Pharmaceutical Use.—A constituent of Tinctura benzoini composita.

Liquidambar Altingia, *Blume.*

A native of Java, and called by the Javanese *Ras-sa-mala.* Undoubtedly yields the fine liquid Storax of Rosamala of the Malayan Archipelago.

Liquidambar styraciflua, *Linn.*

Grows in Cyprus and Central America. It yields a balsamic exudation called "*sweet gum.*"

Salicaceæ, *Lind.* Willow and Poplar Trees.

Amental Exogens, with a 1-celled ovary and numerous cottony seeds.

The bark of different species of Willow (ἰτέα) has been long employed medicinally, and its use has been revived in modern times.

SALIX, SPECIES VARIÆ. Willows.

Generic Characters.—*Catkins* of *entire* scales. *Stamens* 1 to 5. *Fruit* a 1-celled follicle. *Perianth* 0.

The following British species are employed in medicine:—S. fragilis, the *crack willow;* S. alba, the *white willow;* and S. caprea, the *sallow.* The best barks are the most bitter.

Willow bark, of course, varies somewhat according to the species from which it is obtained; but it is thin, flexible, rolling up into a quill, with a greenish-brown epidermis, and white interior; having a slight odour, but a powerfully bitter and astringent taste. It contains *tannin* in such abundance that it has been used for tanning, and a peculiar neutral principle called *salicin.* Water and alcohol take up its active properties.

Salicin, $C_{13}H_{18}O_7=286$, is very bitter, crystallises in white silky needles or laminæ. It is soluble in 5·6 parts of cold, and in much less of boiling water; soluble in alcohol, but insoluble in æther. Sulphuric acid decomposes it, producing a bright-red colour. Gently heated with sulphuric acid and bichromate of potash, it evolves formic and carbonic acids, and is converted into fragrant *oil of meadow sweet* or *hydride of salicyle,* $H,C_7H_5O_2$; also called salicylous acid, and differing from salicylic acid (see p. 356) by an atom less of oxygen. When boiled with dilute sulphuric acid salicin is resolved into glucose and *saligenin*, thus: $C_{13}H_{18}O_7 + H_2O = C_6H_{12}O_6 + C_7H_8O_2$; this last body (saligenin) crystallises in pearly tables, which are soluble in water, and the solution gives an intense blue with the ferric salts.

Salicin is obtained by boiling an aqueous infusion of the bark with hydrated plumbic oxyde, which precipitates the tannin and colouring matter; then filtering and evaporating the solution, when the salicin crystallises.

Action and Uses.—The bark is tonic and astringent. To some extent it is antiperiodic, but is far inferior to quinine. Salicin is eliminated by the urine in the form of saligenin, the secretion giving a deep blue colour with perchloride of iron.

Dose.—1 to 2 ounces of infusion (2 ounces of the bark in 1 pint of water); from 2 to 20 grains of salicin. The latter dose being given like large doses of quinine as an antiperiodic.

CUPULIFERÆ, *Rich.* The Oak, Beech, and Chestnut Order.

Species of oak (δρῦς of the Greeks, and *allon* of the Bible) have been esteemed for their strength and astringency from the earliest times.

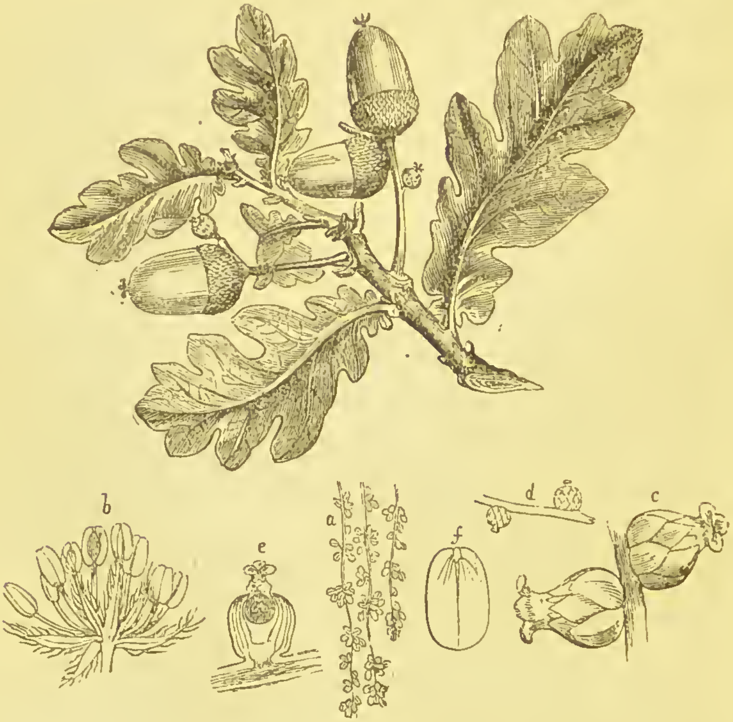

Fig. 65.

QUERCUS PEDUNCULATA, *Willd.* The British Oak.

The common English oak, the *Q. Robur* of Linn., and *Q. pedunculata* of Willd. and others (fig. 65), has its acorns borne on long peduncles, and is thus distinguished from *Q. sessiliflora*, Salisb. (*Q. Robur*, Willd.), which has them clustered upon a very short stalk or sessile, with leaves on elongated stalks. *Eng. Bot.* t. 1845; *Nees von E.* t. 92. Dr Greville states that the characters of the different kinds pass insensibly and completely into each other.

Characters.—Flowers monœcious. *Male catkins* long, pendulous, lax (fig. 65, *a*). *Stamens* 5 to 10 (*b*). *Perianth* (*b*) 5 to 7-cleft. *Female catkins* stalked flower, surrounded by a cup-shaped scaly *involucre* (*c*). *Stigmas* 3, (*c*). *Ovary* 3-celled, 2 of which are abortive. *Nut* (acorn) 1-seeded, surrounded by the woody cup-shaped involucre. Young branches glabrous. *Leaves* on short footstalks, oblong, slightly pubescent beneath, rounded with deep, narrow, somewhat acute sinuses.—*Eng. Bot.* t. 1842; *Nees von E.* t. 93; *Woodv.* pl. 126.

The oak is stripped of its bark in spring and in the beginning of summer. It is usually in long strips, of a coarse fibrous texture.

1. **Quercus Cortex**, *P.B.* *Oak Bark.*

The dried bark of the small branches and young stems of the plant above described. Collected in spring from trees growing in Britain.

Characters and Constituents.—Covered with a greyish shining epidermis, cinnamon-coloured on the inner surface, fibrous, brittle, and strongly astringent. It contains about 15 per cent. of tannic acid, gallic acid, uncrystallisable sugar, pectin, and tannates of lime, magnesia, and potash. An aqueous solution precipitates a solution of gelatin, and slowly converts the collagenous tissues into insoluble leather, and becomes dark purple on the addition of perchloride of iron.

Action and Uses.—Astringent. Used to restrain hæmorrhage, and undue secretions from the skin or mucous membrane. The powdered bark is sometimes employed as a poultice to flabby ulcers, and to moist gangrene.

2. **Decoctum Quercus**, *P.B.* *Decoction of Oak Bark.*

Preparation.—Boil 1¼ ounce of *bruised oak bark* in 1 pint of *water* for ten minutes in a covered vessel, then strain, and wash the bark with enough water to make 1 pint of the decoction.

Uses.—An astringent draught in diarrhœa, but it is chiefly used as a gargle for relaxed throat, and as an injection in leucorrhœa.

QUERCUS INFECTORIA, *Olivier.* **The Gall or Dyers' Oak.**

This small stunted oak is a native of Asia Minor, growing generally throughout the country.

Characters.—A small tree or shrub, with a crooked stem, not above 6 to 8 feet high. *Leaves* on short stalks, 1–1½ inch long, obovate-oblong, with a few coarse mucronated teeth on each side; apex bluntly mucronate, rounded, and rather unequal at the base, smooth, shining on the upper side. *Acorn* solitary, obtuse, 2 or 3 times longer than its hemispherical scaly cup.—*Nees von E.* t. 94; *Steph. and Church*, pl. 152.

Galls are formed by the females of species of *Cynips* (or Diplolepis) piercing the buds of *Q. infectoria* with their ovipositors, and there depositing their eggs. These, producing irritation, cause the juices of the plant to flow towards the wound, and the subsequent enlargement of the part into the form of a gall round the larva. This, when fully developed, escapes by a passage which it excavates in the gall. Galls are not peculiar to this species, nor to the oak. Our native oak has the last twenty years been infested with a species of Cynips, which leads to the development of a large smooth, spherical, and very light gall, replete with tannic acid. Peculiar galls of an irregular shape have now and then been imported from China, where they are known by the name of *Woo-peitzee.* They are very astringent, and are supposed by Dr Schenk to be formed by the puncture of the leaves of the *Rhus semialata*, Murray (Terebinthaceæ), by a species of *aphis.*

Galls were known to Hippocrates, and are described by Dioscorides (i. c. 147) under the name κηκις, which the Indo-Persian writers have converted into *fikees.* They are the *afus* of the Arabs, and well known in India by the name of *majoo-phul.* Galls are imported into England from Smyrna, being produced in Asia Minor; also from Aleppo, the produce of the vicinity of Mosul in Kurdistan.

1. **Gall**, *P.B.* *Galls.*

Excrescences on the tree above described, and caused by the punctures and deposited ova of *Diplolepis Gallæ tinctoriæ*, Latr.

Characters and Constituents.—Hard, heavy, globular bodies, varying in size from ½ inch to ¾ inch in diameter, tuberculated on the surface, the tubercles and intervening spaces smooth; of a bluish green colour on the surface, yellowish-white within, with a small central cavity; intensely astringent.

They yield their properties to water, which is the best solvent; also to proof spirit, and slightly to alcohol and æther. From 500 parts Davy obtained 185 parts of matter soluble in water, of which he states 130 were *tannic acid*, 31 *gallic acid* with a little extractive, 12 of *mucilage*, &c., and 12 of *saline* and *calcareous salts*, the insoluble matter consisting chiefly of *lignin.* Other chemists have obtained from 30 to 60 per cent. of tannic acid. The little colouring matter and large proportion of tannic acid in galls makes them particularly valuable to tanners.

Varieties.—Several varieties of gall are met with in commerce. Besides the names derived from the places whence they are obtained, the officinal or Levant galls are distinguished by their physical characters, as into blue and white galls. The *blue galls* vary in size, and are of a bluish-grey colour. They are gathered before the insect has become perfect, or worked its way out. Some of these are larger, and are called *green galls*, from being of a greenish colour. They display on their otherwise smooth surface a number of bluntly-pointed tubercles, which would appear to be the apices of leaves stimulated into unnatural growth. The best are heavy, hard, shining, and break off with a short flinty fracture. *White galls* are so called from being of a lighter colour than the others, but still of a greyish or yellowish hue. They are distinguished by being perforated with a small round hole, that by which the insect escaped. They are usually less heavy than the others, have a larger internal cavity, and are not so astringent. A third variety, called *large Mecca galls*, are sometimes imported from Bussorah. They are also called Dead Sea apples and *Mala insana*. They are spherical in shape, and surrounded about the centre by a circle of horned protuberances. They are astringent like other galls, and when fresh are said to be purple and shining. They are thought to be the produce of a peculiar variety of *Q. infectoria*, which grows on the mountains near the Dead Sea (*P. J.* viii. 422).

Action and Use (see Tannic acid).—Galls contain a larger proportion of tannic acid than any other vegetable production, and powdered galls is therefore, next to tannic and gallic acids, the most astringent vegetable preparation. In addition to its use as an astringent, in the preparations described below, powdered galls is an appropriate antidote in poisoning by the vegetable alkaloids generally, and by tartar emetic.

Dose of the powder.—As an astringent, from 10 to 20 grains; as an antidote to poisons, from 30 to 60 grains, given before and after the evacuation of the poison.

Pharmaceutical Uses.—The preparation of tannic and gallic acids, and as a constituent of the following:—

2. **Tinctura Gallæ**, *P.B.* *Tincture of Galls.*

Exhaust 2½ ounces of galls in coarse powder with a pint of proof spirit, and obtain 1 pint of the tincture, in the manner directed for tincture of aconite.

Convenient for immediate use as an astringent, and antidote to poisoning, and also as a test for the alkaloids, gelatin, and iron. After it has been kept for some months the tannic acid contained in it is converted into gallic, and it then no longer gives precipitates with the alkaloids and gelatin.

Dose.—½ to 2 fluid drachms.

3. **Unguentum Gallæ**, *P.B.* *Gall Ointment.*

A mixture of 80 grains of *finely powdered galls* and 1 ounce of *benzoated lard.*

Use.—It may be beneficially applied to the rectum to relieve hæmorrhoidal swelling and give tone to the lax mucous membrane. It should not be used during the inflammatory stage.

4. **Unguentum Gallæ cum Opio**, *B.P.*

The above, with 26 grains of powdered opium (see Opium).

ACIDUM TANNICUM, *P.B.* *Tannic Acid.*

$C_{54}H_{22}O_{34}$ or $C_{27}H_{22}O_{17}$.

An acid extracted from galls. It may be obtained by the following process:—

Preparation.—Expose *powdered galls* to a damp atmosphere for two or three days, and afterwards add sufficient *æther* to form a soft paste. Let this stand in a well-closed vessel for twenty-four hours, then, having quickly enveloped it in a linen cloth, submit it to strong pressure, so as to separate the liquid portion. Reduce the pressed cake to powder, mix it with sufficient æther, to which $\frac{1}{16}$th of its bulk of water has been added, to form again a soft paste, and press this as before. Mix the expressed liquids, and expose the mixture to spontaneous evaporation until, by the aid subsequently of a little heat, it has acquired the consistence of a soft extract; then place it on earthen plates or dishes, and dry it in a hot-air chamber at a temperature not exceeding 212°.

Characters and Tests.—In pale-yellow vesicular masses, or thin glistening amorphous scales, with a strongly astringent taste, an acid reaction, an odour resembling dextrin, and an acid reaction; very soluble in water and dilute alcohol, very sparingly soluble in æther. The aqueous solution precipitates solution of gelatin yellowish-white (*leather*), and a piece of raw hide immersed in the solution is converted into the same insoluble compound. The aqueous solution gives with the persalt of iron a bluish-black insoluble precipitate (tannate of iron, the basis of ink); with salts of lead and antimony white insoluble precipitates (tannates of these metals). It decomposes the carbonates of the alkali metals with effervescence, forming soluble tannate of potash, soda and ammonia, astringent solutions which do not precipitate gelatin. These solutions, like the aqueous solution of tannic acid, become mouldy and brown after a few weeks, absorbing oxygen, which converts the tannic into gallic acid. The mineral acids precipitate it from a concentrated solution. Nitric acid converts it into oxalic and saccharic acids. When boiled with dilute hydrochloric or sulphuric acid it unites with water and is converted into glucose and gallic acid, thus: $C_{27}H_{22}O_{17} + 4H_2O = C_6H_{12}O_6 + 3H_3C_7H_3O_5$. A concentrated solution of boiling potash has the same effect.

At 620° tannic acid is decomposed, pyrogallic ($C_6H_6O_3$) and metagallic acid ($C_6H_4O_2$) being formed with the evolution of water and carbonic acid. When burned with free access of air it leaves no residue.

Incompatibilities.—The vegetable alkaloids, mineral acids, and metallic salts generally; lime water, with which it forms a white precipitate of tannate of lime; oxydising agents generally which rapidly convert it into gallic acid. Solutions of albumin and gelatin, with which it forms insoluble precipitates.

Action and Uses.—This is the type and essence of a vegetable astringent. Its constringing power is without doubt due to the formation of the insoluble precipitates formed with the albuminous and gelatinous constituents of the membrane with which it comes in contact, and of the walls of the capillary vessels themselves diminishing at the same time their calibre. By this means the congestion of a hyperæmic surface is relieved, and the flux of watery constituents diminished or arrested. The action on the muscular layer of the mucous membrane is the same, and the contraction of this greatly relieves a congested condition of the extensive vascular surface above it.

Vegetable astringents, therefore, act upon the membranes themselves, upon the blood-vessels contained in them, and upon the contractile tissue, causing condensation of the former, and thus hindering osmotic action; condensation of the coat of the blood-vessels and diminution of their capacity, and so producing a state of comparative anæmia; and contraction of the muscular fibre, whereby the action on the other tissues is increased. This action is most obvious when tannic acid is directly applied to the mucous membrane, but there is no doubt that it occurs generally, in a minor degree, when tannic acid is absorbed into the blood, and is thus diffused throughout the system. But it is probably converted into gallic acid before it reaches the blood. Internally it is useful in fluxes and hæmorrhages of every kind and in every state of the system. Hence it is given in scurvy, hæmatemesis, hæmoptysis, melæna, in dysentery, and cystitis. Topically it is used as an injection when the inflammatory symptoms are past in gonorrhœa, uterine hæmorrhage, leucorrhœa, hæmorrhoids; and as a wash to flabby congested ulcers, or bleeding gums.

Dose.—2 to 10 grains. As a collyrium or urethral injection, 4 grains to 1 ounce of water; as a lotion or vaginal injection, 10 grains to 1 ounce. It may be applied to relaxed fauces in the following form:—

1. **Glycerinum Acidi Tannici,** *P.B. Glycerin of Tannic Acid.*

Preparation.—Rub 1 ounce of *tannic acid* and 4 fluid ounces of *glycerin* together in a mortar, then transfer the mixture to a porcelain dish, and apply a gentle heat until a complete solution is effected. Contains 1 part in 6.

Convenient as a solution of tannic acid. It does not decompose by keeping. It may be applied topically to relaxed parts.

2. **Suppositoria Acidi Tannici,** *P.B. Tannic Acid Suppositories.*

Preparation.—Melt 10 grains of *white wax* and 90 grains of *oil of theobroma* with a gentle heat, then add 36 grains of *tannic acid* and 44 grains of *benzoated lard* previously rubbed together, and mix thoroughly. Pour the mixture while still fluid into suitable moulds of the capacity of 15 grains, or divide it when cold into 12 equal parts, and form them for use as a suppository.

Action. Uses.—A topical application in dysentery, chronic diarrhœa, piles, bleeding, or relaxation of the lower bowel.

3. **Suppositoria Acidi Tannici cum Sapone,** *P.B.*

Prepared by mixing 36 grains of tannic acid with 50 grains of glycerin of starch, and 100 grains of curd soap in powder, adding enough starch to give the required consistence, and dividing as No. 2.

4. **Trochisci Acidi Tannici,** *P.B. Tannin Lozenges.*

Dissolve 360 grains of *tannic acid* in 1 fluid ounce of *water;* add ½ fluid ounce of *tincture of Tolu,* previously mixed with 2 fluid ounces of *mucilage of gum acacia;* then add 1 ounce of *gum acacia in powder*, and 25 ounces of *refined sugar* in powder, also previously well mixed. Form into a proper mass; divide it into 720 lozenges, and dry these in a hot-air chamber with a moderate heat.

Each lozenge contains half a grain of tannic acid.

Dose.—1 to 6 lozenges.

Acidum Gallicum, *P.B.* *Gallic Acid.*

$$3HO,C_{14}H_3O_7+2HO= \text{or } H_3C_7H_3O_5,H_2O=170+18.$$

A crystalline acid prepared from galls.

Preparation.—Place 1 pound of *galls in coarse powder* in a porcelain dish, pour on as much of the *water* as will convert them into a thick paste, and keep them in this moistened condition for six weeks, at a temperature of between 60° and 70°, adding water from time to time to supply what is lost by evaporation. At the end of that time boil the paste for twenty minutes with 45 ounces of *water*, strain through calico, and when the fluid has cooled collect on a filter the crystalline deposit which has formed, and let it drain. Press it strongly between folds of filtering paper, and redissolve it in 10 ounces of boiling water. When the fluid has cooled to 80° pour it off from the crystals which have formed, wash these with 3 ounces of ice-cold water, and dry them first by filtering paper, and finally by a temperature not exceeding 100°. More acid may be obtained by the action of boiling water on the marc and evaporating to the bulk of 10 ounces.

By exposure to the air the tannic acid is gradually decomposed, and gallic acid formed. This is extracted by the boiling water, and deposited from it on cooling, being comparatively insoluble. Any undecomposed tannic acid is left in the mother liquor.

Characters and Tests.—Crystalline, in acicular prisms or silky needles, nearly white or of a pale fawn colour, of an acidulous astringent taste. Soluble in 100 parts of cold, and 3 parts of boiling water; freely soluble in alcohol, sparingly so in æther. The aqueous solution gives no precipitate with solution of isinglass (gelatin). It gives a bluish-black precipitate with a persalt of iron. When dried at 212° the crystals lose 9·5 per cent. of their weight of water (= a molecule). Heated to 410° gallic acid is wholly volatilised being converted into pyrogallin and carbonic anhydride: $H_3C_7H_3O_5=C_6H_6O_3+CO_2$. Above this temperature the pyrogallin is decomposed with the formation of metagallic acid and water. Gallic acid is tribasic, and some of its salts are crystalline. Solutions of gallates of the alkalies absorb oxygen, and become brown. The gallates of the heavy metals are insoluble.

Action and Uses.—Taken internally it acts as tannic acid, that substance being rapidly converted into gallic acid in the body. As a topical astringent it is far inferior to tannic acid, for it does not precipitate albuminous and gelatinous solutions.

Dose.—2 to 10 grains as a hæmostatic.

1. **Glycerinum Acidi Gallici,** *P.B.* *Glycerin of Gallic Acid.*

Prepared with the same proportions, and in the same manner as glycerin of tannic acid. Contains 1 part of acid in 6.

Use.—A convenient form of solution, as it does not decompose by keeping.

Ulmaceæ, *Mirbel.*

ULMUS CAMPESTRIS, *Linn.* The Broad-Leaved Elm.

The Elm is supposed to be the *πτεϱέα* of Dioscorides.

Characters.—60–80 feet high, with rugged bark. *Leaves* rhomboid-ovate, acuminate, wedge-shaped, and oblique at the base, always scabrous above, downy beneath, doubly and irregularly serrated, sometimes incurved. *Branches* wiry, slightly corky, when young, light brown and pubescent. *Flowers* perfect. *Perianth* bell-shaped, 5-cleft, persistent. *Stamens* 5. *Styles* 2. *Capsule* compressed, oblong, with a broad membraneous wing all round, deeply cloven, naked.—*Nees von E.* t. 104; *Woodv. Med. Bot.* plate 197.

The bark should be removed in spring.

1. **Ulmi Cortex,** *P.B.* *Elm Bark.*

The dried inner bark of the species above described indigenous to Britain.

Characters and Constituents.—A tough brownish-yellow bark; in broad flat pieces about $\frac{1}{8}$ of an inch thick, smooth on both surfaces; the external one being distinguished by broad marks of the knife used in removing the outer layer; odourless; taste mucilaginous, slightly bitter, and astringent. Its decoction is turned green by perchloride of iron, and precipitates with a solution of gelatin (indicating the presence of tannic acid).

It contains about 3 per cent. of tannic acid, a little resin, and 20 per cent. of gum and mucilage.

Action and Uses.—Demulcent and astringent. Supposed to be beneficial in chronic squamous skin diseases. It is employed in the following form:—

2. **Decoctum Ulmi,** *P.B.* *Decoction of Elm Bark.*

Preparation.—Boil $2\frac{1}{2}$ ounces of *elm bark* cut in small pieces in 1 pint of *water* for ten minutes, strain, and wash the bark with enough water to make 1 pint of the decoction.

Dose.—2 to 4 fluid ounces.

Ulmus fulva, *Mich.* *The Slippery* or *Red Elm.*

A North American species. It furnishes a bark replete, like the root of Althea, with mucilage. It has an agreeable odour like Fenugreek. The powder is used in America as a demulcent poultice.

Cannabinaceæ, *Lindley.* The Hemp and Hop Family.

Only distinguished from the Moraceæ by the absence of albumen.

CANNABIS SATIVA, *Linn.* Common Hemp.

The hemp appears to be a native of the Persian region, where it is subjected to great cold in winter, and to considerable heat in summer. It has thus been able to travel on the one hand into Europe, and on the other into India; so that the varieties produced by climate have been regarded as distinct species, the European being called *C. sativa*, and the Indian *C. indica.* The name κάνναβις, by which it was known to the Greeks, seems to be derived from the Arabic *kinnub*, the *canape* of the Middle Ages, Dutch *kinnup* and *hinnup*, German *hanf*, whence the English *hemp.* Herodotus mentions it as Scythian. Bieberstein met with it in Tauria and the Caucasian region. It is well known in Bokhara, Persia, and is abundant in the Himalayas. It seems to have been employed as an intoxicating substance in Asia and Egypt from very early times, and even in medicine in Europe in former times, as was noticed in Dale (*Pharmacologia*, i. 133) and Murray (*Apparat. Medicaminum*, iv. pp. 608–620). It has of late years been brought into European notice by Dr O'Shaughnessy.

Characters.—A diœcious (occasionally monœcious) annual, from 3 to 10 feet high. *Root* white, fusiform. *Stem* erect; when crowded, simple; but when growing apart, branched, angular, and, like the whole plant, covered with fine but rough pubescence. *Leaves* opposite or alternate, on long petioles, scabrous, digitate, composed of from 5 to 7 narrow, lanceolate, sharply serrated leaflets, of which the lower are the smallest, all tapering at the apex into a long entire point. *Stipules* subulate. *Males* on a separate plant. *Flowers* in drooping, axillary, or racemose panicles, with subulate *bracts. Perianth* 5-parted; segments not quite equal, downy. *Stamens* 5; filaments short; anthers large, pendulous, 2-celled; cells united by the back, opening by a longitudinal slit. *Females* in a crowded spike-like raceme, with leafy *bracts.* Perianth of a single, small, spathe-like *sepal,* which is persistent, acuminate, ventricose at the base, embracing the ovary, and covered with short brownish glands. *Ovary* subglobular, 1-celled, with one pendulous ovule. *Style* short. *Stigmas* 2, elongated, glandular. *Nut* ovate, greyish-coloured, smooth, covered by the calycine sepal, bivalved but not dehiscing, and enclosing a single oily seed. *Seed* pendulous. Embryo doubled upon itself. Radicle elongated, cotyledons incumbent, plano-convex.—*Berg. u. Schmidt, Off. Gewächse,* plate xix. *b.*

The Indian plant has been thought to be distinct from the European one; but, like Dr Roxburgh and others, Dr Royle was unable when in India to observe any difference between the plant of the plains and that of the hills of India, nor between these and the European plant. The Indian secretes a much larger proportion of resin than is observable in the European plant; but a difference is observed in this point in India between plants grown in the plains and in the mountains, and also between those grown more or less closely together. The natives plant them wide apart, to enable them to secrete their full powers. Dr Royle, in calling attention to the uses of this plant in his *Illustr. of Himalayan Botany*, states that "the leaves are sometimes smoked in India, and occasionally added to tobacco, but are chiefly employed for making *bhang* and *subzee*, of which the intoxicating powers are so well known. But a peculiar substance is yielded by the plants on the hills, in the form of a glandular secretion, which is collected by the natives pressing the upper part of the young plant between the palms of their hands, and then scraping off the secretion which adheres. This is well known in India by the name of *churrus*, and is considered more intoxicating than any other preparation of the plant: it is so highly esteemed by many Asiatics as to serve them both for wine and opium: it has in consequence a variety of names applied to it in Arabic, some of which have been translated as 'grass of faqueers,' 'leaf of delusion,' 'increaser of pleasure,' 'exciter of desire,' 'cementer of friendship,' &c. Linnæus was well acquainted with its 'vis narcotica, phantastica, dementens' (anodyna et repellens). It is as likely as any other to have been the *Nepenthes* of Homer." (*l. c.* p. 334.)*

Dr O'Shaughnessy has described in detail the different preparations, as—

1. *Churrus*, the concreted resinous exudation from the leaves, slender stems, and flowers. It is collected in various ways; that of the Himalayas is much esteemed, that of Herat and of Yarkund still more so.
2. *Ganjah*. This is the dried plant which has flowered, and from which the resin has not been removed. The bundles are about two feet long, and contain twenty-four plants.
3. *Bang*, *Subjee*, or *Sidhee* (Hind.), *Hashîsh* (Arab.), is formed of the larger leaves and capsules without the stalks.

1. **Cannabis Indica**, *P.B.* *Indian Hemp.*

The dried flowering tops of the female plants of the species above described, grown in India, from which the resin has not been removed.

Characters and Composition.—Tops consisting of one or more alternate branches, bearing the remains of the flowers and smaller leaves and a few ripe fruits, pressed together in masses which are about 2 inches long, harsh, of a dusky-green colour and a characteristic odour. The essential constituents are *volatile oil* and *resin*.

Messrs Smith of Edinburgh obtained the resin in a state of purity by the addition of water to a concentrated tincture of the tops made with rectified spirit. They found that proof spirit would not extract the resin. According to their experiments, the resin is the essential constituent of the plant, ¾ of a grain acting as a powerful narcotic, and 1 grain producing the full effects of the plant. It is very soluble in alcohol and æther, as well as in the fixed and volatile oils, partially soluble in alkaline, insoluble in acid solutions; when pure, of a blackish-grey colour. The volatile oil exists in the proportion of about 0·3 per cent. of the dried tops. It is lighter than water, of an amber colour, and the oppressive odour of the fresh plant. According to Bohling and Personne, the vapour causes a peculiar sensation of shuddering, with motor excitement, followed by prostration and syncope. Personne has resolved it into two bodies, a colourless liquid named *cannabene*, $C_{18}H_{20}$, and a solid hydride of this, $C_{18}H_{22}$. The *Ganjah*, which is sold for smoking chiefly, yields to alcohol about 20 per cent. of resinous extract, composed of *churrus* and chlorophyll.

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* In an old Chinese book preserved in the Bibliothèque Nationale at Paris, it is stated that a preparation of *Chanvre* or *Mayo* was used in China in the third century of our era as an anæsthetic. The hemp plant is esteemed for its intoxicating properties in many parts of the world. Dr Daniell states that it is smoked in large quantities by the natives of Congo, Angola, and South Africa, being called by them *Dakka* and *Damba*. The leaves of *Catha edulis* and *C. spinosa*, which are masticated and drunk in infusion by the Arabs at Aden, under the name of *Kat*, afford the same kind of pleasurable excitement.

Action. Uses.—All these preparations are capable of producing intoxication, whether the *churrus* be taken in the form of a pill or with conserve, or the dried leaf be rubbed up in milk and water with a little sugar and spice, or smoked. The most prominent effect of a large dose is delirium of a pleasing character, and this is followed by exhaustion. In company with my friend, Dr Symes Thomson, I once witnessed the full effect of this drug; and they are very characteristic. The subject was a medical student, a pallid weakly young man, addicted to opium eating. On one occasion he substituted the extract of Indian hemp for opium, and about an hour after the dose (the quantity was indeterminable), Dr Thomson and I found him sitting up in bed, pale, and with dilated pupils, gesticulating and talking wildly, and for the most part incoherently, now pointing energetically before him and vociferating, and then turning towards us or falling back in bed in a violent fit of laughter. The pulse was weak and rapid; and in the intervals there was great exhaustion and apathy. After about two hours the delirium rather suddenly gave way, and he called for food and ate voraciously three or four hunches of bread and butter in my presence. The following day he was very weak, but there were no nervous symptoms. In the intervals of apathy the patient often lapses into a semi-cataleptic condition, and if the limbs be raised they only very slowly return to a position of rest. Its general effects are, remarkable *increase of appetite*, unequivocal *aphrodisia*, and great *mental cheerfulness.* Mr Ley found it useful in *relaxing spasm* and producing sleep, and during its action observed an abatement of pain. Mr Donovan found its power great in temporarily destroying sensation and subduing the most intense neuralgic pain. Professor Miller of Edinburgh considers its virtue to consist in a power of controlling inordinate muscular spasm. Dr Glendinning says that in his hands its exhibition has been followed by manifest effects as a soporific or hypnotic in conciliating sleep, as an anodyne in lulling irritation, as an antispasmodic in checking cough and cramp, and as a *nervous stimulant in removing languor and anxiety.* And Dr Christison gives the following high testimony to its virtues:—"I have known 2 grains of alcoholic extract put an end, promptly and permanently, to the agonising pain caused by impaction of a biliary calculus. I have long been convinced that for energy, certainty, and convenience, Indian hemp is the next anodyne, hypnotic, and antispasmodic, to opium, and often equals it." The extract made in India has been found to be much stronger than that produced here, owing probably to deterioration of the drug from packing and changes of temperature.

2. **Extractum Cannabis Indicæ,** *P.B. Extract of Indian Hemp.*

Preparation.—Macerate 1 pound of *Indian hemp* in coarse powder in 4 pints of *rectified spirit* for seven days, and press out the tincture. Distil off the spirit, and evaporate by a water-bath to the consistence of a soft extract.

The Yarkund extract is of a dark blackish green; another kind is of a dirty olive colour. Its odour is fragrant and narcotic; taste slightly warm, bitterish, and acrid.

Dose.—$\frac{1}{2}$ to 2 grains.

It is employed in the preparation of the following:—

3. **Tinctura Cannabis Indicæ,** *P.B. Tincture of Indian Hemp.*

A solution of 1 ounce of the *extract* in 1 pint of *rectified spirit.* 1 fluid ounce contains nearly 22 grains.

Dose.—10 to 40 minims ($=\frac{1}{2}$ grain nearly to 2 grains nearly).

Use.—It has been given to relieve neuralgic headache; as an anodyne generally, and to relieve the paroxysms of hydrophobia and tetanus; but its use in these conditions has been superseded by chloroform. It is often beneficial in chorea, and in some forms of epilepsy.

HUMULUS LUPULUS, *Linn.* The Common Hop.

The hop plant was known to the Romans, being considered to be the *Lupus salictarius* of Pliny. It grows wild in many parts of Europe, and was seen by Bieberstein among the bushes and hedges of the Caucasus. It is found in China, is said to be wild in North America, and to be a native of this country. Humalineæ, or hop-grounds, are mentioned in the ninth century in Germany. In the thirteenth century hops were introduced into the breweries of the Netherlands. Its culture is supposed to have been introduced into this country from Flanders in the reign of Henry VIII. Hops, as well as Newcastle coals, were petitioned against by the city of London, the former "in regard that they would spoil the taste of drink and endanger the people;" whereupon Henry VIII. issued an injunction "not to put any hops or brimstone into the ale." As in the history of many other prejudices, we observe at length a complete reversal of opinion, hops being now considered indispensable in the brewing of all malt liquors.

Characters.—A perennial rooted plant, with annular pliable stems, which on poles or in hedges climb to a great extent, twining from right to left. *Leaves* opposite, the upper alternate, on long, often winding petioles, the smaller heart-shaped, the larger 3 to 5-lobed, serrated, veiny, and extremely rough, with prickle-like pubescence. *Stipules* 2, bifid, between the petioles, reflexed. Flowering branches axillary. *Flowers* numerous, yellowish-green. *Males* on a separate plant (a few on the female), in axillary panicles. *Perianth* 5-parted; segments oblong, spreading. *Stamens* 5; filaments short; anthers with a projecting apex, oblong, 2-celled, opening by longitudinal lateral slits. *Pollen* globose. *Females,* like the males, on a separate plant, in dense catkins or strobiles, with membranous concave *bracts,* each supporting a flower. In place of a perianth, there is a membranous *scale* or *sepal,* which embraces the ovary and grows with it. *Ovary* ovate, subcompressed, 1-celled, with a single *ovule.* *Stigmas* 2, elongated. *Fruit* a *strobile* or catkin, formed by the enlarged bracts and scales or sepals, which are glandular and embrace the *nuts.* These are small, subglobular, erect, 1-seeded. *Pericarp* hard, but fragile, covered with yellow, cellular, superficial aromatic glands (*lupuline*). *Seed* pendulous; testa membranous. *Embryo* without albumin, spiral, with long cotyledons. Radicle roundish, turned towards the hilum.—*Nees von E.* 101; *Steph.* and *Church.* pl. 41.

Hop plants grown from root-sets come to perfection in the third year following. They spring out of the ground about the end of April, and flower about the end of August. The catkins are fit

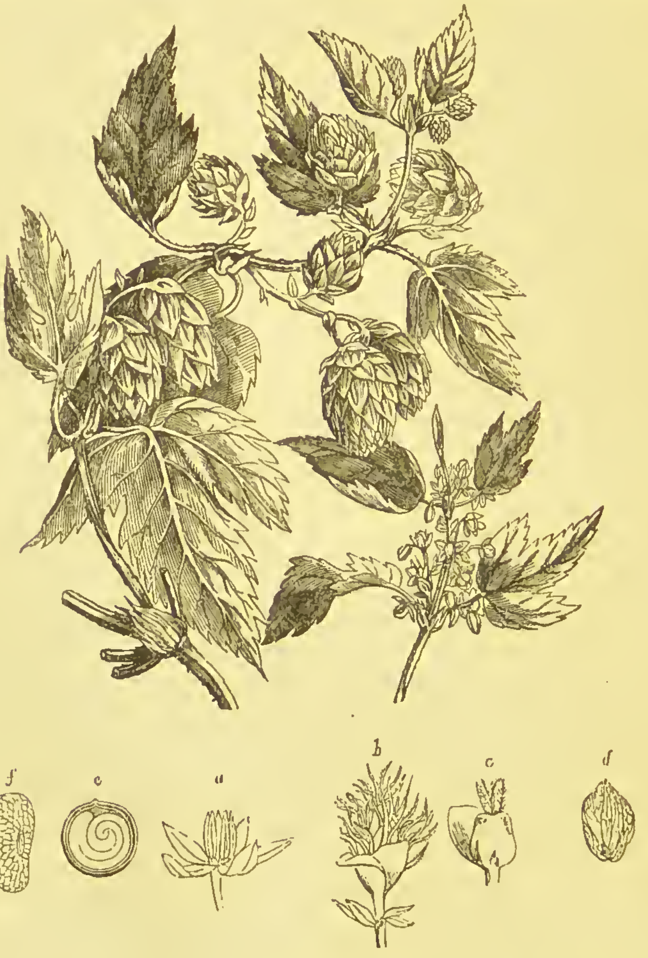

Fig. 66.

Humulus Lupulus, male and female; the former on the right.
a, male flower; *b,* female flowers; *c,* a single one; *d,* bract; *e,* embryo; *f,* grain of lupulin.

to gather from the beginning of September to the middle of October. They are then picked, dried by artificial heat in kilns, and packed in large long bags, or pockets. Hops consist of the leaf-like bract and of the scale-like sepal which invests the seed-nut. This, or rather the scale and the base of the bract, is covered with numerous superficial glands, which have been called *lupulinic glands*, and simply *lupuline*, though this name is objectionable, as also indicating the peculiar or bitter principle. The glands are yellow, shining, sub-conical, or kidney-shaped, cellular, somewhat transparent, and sessile; the point of attachment is called the hilum (see fig. 66, *f*, which is a magnified view from Raspail).

Two varieties of the hop plant are particularly distinguished—one cultivated near Canterbury and in East Kent, of which both the plants and catkins are smaller; the latter being ovoid, about an inch and a half in length, of a pale but lively yellowish-green colour, and of a fine aromatic fragrance. The West Kent or Sussex hop grows to a much larger size, is considered hardier, and its catkins are about two and a half, sometimes four inches in length, but do not bring so high a price in the market as the East Kent hops. Root-sets from the female plant are alone planted by cultivators. Some male blossoms are always produced on the female plants, and suffice for the purpose of fertilising them. Dr Royle failed to learn or discover whether the female ever changed into a male plant, or *vice versâ*, as has been observed with the nutmeg tree. Owing to the kindness of Mr Masters of Canterbury and of Joseph Royle, Esq., Dr Royle has introduced the hop plant into the Himalayas, where it is now flourishing alongside of the China tea-plant. The successful cultivation of hops will bring malt liquors more within the reach of European soldiers, and assist in detaching them from the pernicious spirituous compounds of the bazaars, which now destroy the health and shorten the lives of thousands.

Lupulus, *P.B.* *Hop.*

The dried strobiles of the female plant above described. Cultivated in England.

Characters and Constituents.—Strobiles of greenish-yellow colour with minute yellow grains (lupuline) adherent to the base of the scales. Odour aromatic, taste bitter.

The bitter aromatic principle resides in the so-called "lupuline." Dr Ives of New York procured from 6 pounds of hops about 6 ounces of these grains. Payen found them to contain about 2 per cent. of *volatile oil*, 10·3 of *bitter principle*, and from 50 to 55 of *resin*. The scales contain from 3 to 5 per cent. of *tannic acid*, and only a trace of the essential constituents of the grains. The volatile oil has a greenish or reddish-brown colour, according as it is obtained from the fresh or dried strobiles. Personne states that it contains *valerol* (see Valerian). According to Griessmayer, hops contain a minute quantity of *trimethylamine* (see p. 357), and a *liquid alkaloid* of the odour of conia.

Action. Uses.—Stomachic, tonic, and slightly narcotic. The property of hops of giving the bitter to beer, and, by preventing acetous fermentation, of enabling it to be kept much longer, is well known. To it no doubt is owing a portion of the stomachic properties of malt liquors, as we see exemplified in the bitter ales. Hops are hypnotic, especially when stuffed into a pillow; but they should be first moistened with spirit to prevent the rustling noise. Fomentations of hop have been used. The lupulinic or hop glands may be given in doses of 6 to 12 grains made into pills.

1. **Infusum Lupuli**, *P.B. Infusion of Hop.*

Preparation.—Infuse ½ an ounce of *hops* in 10 fluid ounces of *boiling water* for two hours in a covered vessel, and strain.

Dose.—1 to 2 fluid ounces.

2. **Tinctura Lupuli**, *P.B. Tincture of Hop.*

Prepared by exhausting 2½ ounces of *hops* with 1 pint of *proof spirit*, and obtaining 1 pint of tincture, as directed for Tinctura aconiti.

The East Kent hops contain a larger proportion of glands than the Sussex hops. Rectified spirit is the best solvent of the constituents of the hop.

Dose.—½ to 2 fluid drachms.

3. **Extractum Lupuli**, *P.B. Extract of Hop.*

Preparation.—Macerate 1 pound of *hop* in 1½ pint of *rectified spirit* for seven days, press out the tincture, filter, and distil off the spirit, leaving a soft extract. Boil the residual *hop* with 1 gallon of *water* for one hour, then express the liquor, strain and evaporate by a water-bath to the consistence of a soft extract. Mix the two extracts, and evaporate at a temperature not exceeding 140° to a proper consistence for forming pills.

Action.—In the process the aromatic principle is dissipated. Tonic and stomachic.

Dose.—5 to 15 grains.

MORACEÆ, *Lind.* The Mulberry and Fig Family.

Plants of the Urtical alliance, characterised by a fleshy receptacle or succulent calyx, a solitary suspended ovule, and a hooked albuminous embryo with a superior radicle.

MORUS NIGRA, *Linn.* The Mulberry.

The mulberry is a native of the Caucasus and the adjacent parts of Persia and Syria. It is cultivated throughout Europe. It is the Μορέα ἢ Συκαμινέα of Dioscorides and of other Greeks, and is mentioned in Luke xvii. 6, as συκάμινος. It has no doubt been known from the earliest times.

Characters.—Tree 25 to 30 feet high. *Leaves* alternate, roundish, often lobed, cordate, rather acuminate, coarsely serrated, pubescent; *stipules* oblong, deciduous. *Flowers* monœcious, thickly set, or distinct. *Catkins* unisexual. *Perianth* 4-lobed; in each the lobes concave. *Male* flowers in a spike. *Stamens*

4, alternate with the segments of the perianth. *Female* flowers clustered in ovoid catkins. *Sepals* 4, scale-like, overlapping each other, becoming fleshy. *Stigmas* 2, linear, glandular. *Fruit* formed of the fleshy sepals, each enclosing a dry achenium. *Seed* pendulous. *Embryo* curved, in fleshy albumen.—*Nees von E.* pl. 100; *Steph. and Ch.* pl. 39.

Mulberries, formed by the lateral aggregation of the several female flowers, constitute an ovoid spurious berry (*sorosis*); they are at first reddish, but become of a deep purple colour when ripe, and contain an agreeable subacid juice.

Succus Mori, *P.B.* *Mulberry Juice.*

The juice of the ripe fruit.

Characters and Constituents.—Of a dark violet colour, with a faint odour and an acidulous taste. According to Van Hees, 100 parts contain 9·19 of sugar; 1·86 of free acid, supposed to be malic; 0·39 of albuminous matter; 2·03 of pectin, fat, gum, and salts; 1·82 of cellulin and insoluble matter, and 84·71 of water.

It is used in the preparation of the following:—

Syrupus Mori, *P.B.* *Syrup of Mulberries.*

Preparation.—Heat 1 pint of *mulberry juice* to the boiling point, and when it has cooled filter it. Dissolve 2 pounds of *refined sugar* in the filtered liquid with a gentle heat, and add 2½ fluid ounces of *rectified spirit.* The product should weigh 3 pounds 6 ounces, and have the specific gravity 1·33.

Action and Uses.—Refrigerant and slightly laxative. It is chiefly used for colouring mixtures, and as a laxative for infants.

Dose.—1 fluid drachm.

FICUS CARICA, *Linn.* **The Fig.**

A native of Asia, introduced into Europe.

The fig (σῦκον) has been employed as an article of diet and as a medicine from very early times.

Characters.—A small tree. *Leaves* cordate, often palmately lobed, scabrous above, pubescent beneath. *Flowers* monœcious, numerous, stalked, and enclosed within a pear-shaped fleshy receptacle, which converges so as to leave only a small orifice at the apex, forming what is commonly called the fruit or fig, with a few bracteal scales at its base. *Male—Perianth* 3-lobed. *Stamens* 3. *Female—Perianth* 5-parted. *Ovary* semi-adnate; *style* single; *stigmas* 2. *Achenium* sunk into the fleshy receptacle, lenticular, hard. *Embryo* curved, within fleshy albumen.—*Nees von E.* 97; *Steph. and Ch.* 154.

The trunk and branches of the common and other fig trees abound in a milky, usually acrid juice. This is found also in unripe figs; but as they ripen, mucilaginous and saccharine matter take its place. The fig becomes soft, juicy, and of a delicate flavour in favourable climates. The process of "caprification" is practised, to assist the ripening of the fruit. This consists in puncturing the fruit with a sharp instrument covered with oil. When nearly ripe they are dried by exposure on trays, and exported in large quantities from the south of Europe. They are imported into India from Affghanistan and Persia.

Ficus, *P.B.* *Fig.*

The dried fruit of the plant above described. Imported from Smyrna.

Action. Uses.—Figs are dietetical, slightly laxative with those unaccustomed to their use. Chiefly employed as a demulcent, or, heated and split open, applied as a poultice.

Pharmaceutical Use.—An ingredient of Confectio sennæ.

DORSTENIA, *Linn.* SPECIES VARIÆ. Contrajerva.

Contrajerva root is supposed to have been first made known by Monardes; others say that it was first sent by Sir F. Drake to Lecluse, who named it *Drakena radix.* Contrajerva signifies *counter-poison.*

From the statement of Martius and others, it appears that several species, as *D. braziliensis*, *Houstoni*, *Drakena*, all yield it. Dr Pereira states that none of the roots of *D. contrajerva* are met with in commerce.

The contrajerva root of commerce is imported from Brazil, and probably yielded chiefly by *D. braziliensis*, especially as it resembles it in character. The part which is used is the root, or rootstock, which is præmorse, an inch or two in length, scaly or wrinkled, of a greyish colour externally, paler within, with numerous slender radicles from its sides, as well as one or two long tapering ones from its base. The odour is somewhat aromatic; the taste slightly bitterish, warm, and aromatic. The radicles have less of these sensible properties, which are readily extracted by spirit, and partially by boiling water. They depend chiefly on a volatile oil, resin, bitter extractive, and starch.

Action. Uses.—Stimulant, tonic, diaphoretic, and emetic. It may be used as a substitute for serpentary. The roots soon lose their virtues by keeping.

PIPERACEÆ, *Richard.* Pepper-worts.

The Piperaceæ are allied in some respects to Polygonaceæ, in others to Urticaceæ. They chiefly inhabit the tropical parts of Asia and America, and are characterised by pungent and aromatic properties. Besides the officinal species, the *Piper Betle* is much cultivated. and famed for its moderately pungent and aromatic properties, its leaf being employed to envelope the fragments of *Areca Catechu*, and of lime, which forms the famed masticatory of the East, known as *pan* or *betle.*

PIPER, *Linn.*

Generic Characters.—*Shrubs*, rarely trees, aromatic, with knotted, jointed branches. *Leaves* alternate, very entire, often nerved. *Spike* supported by a spathe at the base, opposite to the leaves, rarely terminal, cylindrical, sometimes sub-globular. *Flowers* spicate, hermaphrodite, each supported by a scale. *Stamens* indeterminate, often two. *Anthers* 2-celled. *Ovary* 1-celled; *ovule* solitary, erect; *stigma* trifid or multifid. *Berry* 1-seeded.—*H. B. and K.*

PIPER NIGRUM, *Linn.* Black Pepper.

The πεπέρι of Hippocrates and Dioscorides is no doubt our pepper, the name being derived from the Persian *Pilpil* (see *P. longum*). The Hindoos were probably the first to investigate the properties of pepper. It grows in abundance on the Malabar coast, &c., whence it is now imported, as well as from the Malay Peninsula, Sumatra, and other islands. It is cultivated in the West Indies.

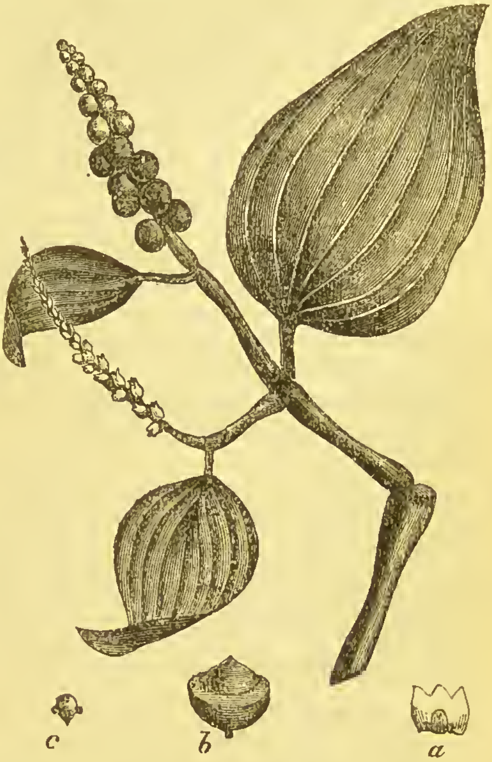

Fig. 67.—*Piper nigrum.*—*a*, flower opened; *b*, fruit, pericarp partly removed; *c*, embryo.—*Woodv. Med. Bot.* pl. 187.

Characters.—The pepper-vine is a perennial, with a trailing or climbing, round, flexuose stem, from 8 to 12 feet in length, dichotomously branched, articulated, swelling near the joints, and often radiating. The *leaves* are distichous, broadly ovate, acuminate, occasionally somewhat oblique, with 5–7 prominent *nerves* beneath, dark-green, and glossy above, pale glaucous green beneath; *petioles* rounded, nearly an inch in length. *Spikes* opposite the leaves, stalked, from 3 to 6 inches long, slender, drooping. *Flowers* some male, others female, while sometimes they are furnished with both stamens and pistil (*Lindl.*). *Stamens* 3. *Fruits* distinct, round, sessile, about the size of a pea, at first green, then red, afterwards black, covered by pulp.—*Nees von E.* pl. 21; *Steph. and Ch.* pl. 174.

The berries are gathered before they are quite ripe, and dried in the sun. They then become black and wrinkled from the drying up of the pulpy part, which covers a round greyish-white seed.

White pepper is the same berry allowed to ripen, when its pulpy part is easily removed by soaking in water and subsequent rubbing. The dried pulpy covering of the black pepper has in this country been removed by mechanical means, to form a white pepper.

1. **Piper nigrum,** *P.B.* *Black Pepper.*

The dried unripe berries of the plant above described. Imported from the East Indies.

Characters and Constituents.—Small, roundish, wrinkled; tegument brownish-black, containing a greyish-yellow globular seed. Odour aromatic; taste pungent and bitterish.

The essential constituent is an *acrid resin*, besides which there are from 1 to 2 per cent. of *volatile oil* isomeric with oil of turpentine, and having the odour and taste of pepper; a little *fatty oil;* from 2 to 3 per cent. of *piperin*, and about 5 per cent. of inorganic matter.

The *resin* is soft, becomes solid at 32°, is soluble in alcohol and æther, and unites readily with all fatty bodies. Its taste is extremely pungent and acrid, and it is very abundant in black pepper, the properties of pepper depending chiefly on this resin.

Piperin ($C_{17}H_{19}NO_3$) is isomeric with morphia. It is a neutral body, and exists as colourless rhombic crystals, tasteless and odourless, nearly insoluble in water, soluble in alcohol and acetic acid, less so in æther, fusible at 212°, and volatile. Nitric acid decomposes it (developing the odour of oil of bitter almonds) into *piperic acid* ($HC_{12}H_9O_4$) and *piperidia* ($C_5H_{11}N$), a powerful oily alkaloid with an odour of pepper and ammonia, and resembling the latter in its reactions, precipitating bases, neutralising strong acids, and forming crystalline salts.

Adulterations.—Ground pepper is commonly adulterated with various kinds of starch, which may be readily recognised by the microscope.

Action and Uses.—A pungent stimulant, supposed to possess febrifuge properties. It is a grateful stomachic, and is much used as a condiment and to prevent the attacks of the moth. It is given with aperients to facilitate their action and prevent griping; and as a stimulant in passive hæmorrhoids.

Pharmaceutical Uses.—An ingredient of Confectio opii, Pulvis opii compositus, and the following:—

Confectio Piperis, *P.B. Confection of Pepper.*

A mixture of 2 ounces of finely powdered *black pepper*, 3 ounces of finely powdered *caraway fruit*, and 15 ounces of *clarified honey.*

Action. Uses.—A moderate stimulant. It has been introduced as a substitute for *Ward's Paste*, which obtained celebrity as a cure for *hæmorrhoids.* Brodie supposed that it relieves them in consequence of a gentle stimulant action on the colon.

Dose.—1 to 2 drachms twice or thrice a day.

CHAVICA ROXBURGHII, *Miquel.* Long Pepper.

Long pepper has been employed by the Hindoos in medicine from the earliest times. Its Sanscrit name *pippula* seems to have been the original of the Greek πεπέϱι, and the πεπεϱέως ῥίζα would appear to be its roots, which, called *pipulla mool*, are still extensively employed throughout the East (see *Hindoo Med.* p. 86).

A native of the woody hills of the Circars, as well as along the foot of the Himalayas; cultivated in Bengal.

Characters.—Root woody. *Stems* shrubby, climbing, jointed. Lower *leaves* ovate-cordate, 3 to 5-nerved; upper ones on short petioles, oblong, acuminate, oblique, and somewhat cordate at the base, obsoletely 4 to 5-nerved and veined, coriaceous, smooth. *Peduncles* erect, longer than the petioles. *Spikes* almost cylindrical.—*Nees von E.* 26; *Steph. and Church*, pl. 174.

This plant is cultivated also on account of its roots, which, as well as the thickest parts of the stems, are cut into small pieces and dried, and form an article of commerce all over the East. The spike of berries forms a long, nearly cylindrical body, varying from 1 to 1½ inch in length. The berries are most pungent in their immature state, and are at that time dried, when the whole becomes of a greyish colour. Long pepper has a faint aromatic odour when bruised, but a powerfully pungent taste. According to Dulong, its composition is analogous to that of black pepper.

Action. Uses.—Those of black pepper.

CUBEBA OFFICINALIS, *Miquel*. **The Cubeb Pepper.**

Cubebs were probably first made known through the Hindoos to the Arabs, being the *kubabeh* of the latter, and the *kubob-chini* of the former. It is not probable that they were known to the Greeks. (See *Hindoo Med.* p. 85.) Dr Pereira has adduced evidence that they were employed in England 500 years ago. They are the *Piper caudatum* of old writers.

Characters.—*Stem* climbing; branches round, the thickness of a goose-quill, smooth rooting at the joints; when young, petioles minutely downy. *Leaves* 4 to 6½ inches long, 1½ to 2 inches broad, stalked, oblong, or ovate-oblong, acuminate, rounded or obliquely cordate at base, strongly veined, netted, coriaceous, very smooth. *Spikes* at the end of the branches, opposite the leaves, diœcious, on peduncles the length of the petioles. *Fruit* rather larger than black pepper, globose, on pendicles about ½ an inch long (*Lindley*). A native of Java and Prince of Wales' Island.—*Nees von E.* 22; *Steph. and Church*, plate 175.

1. **Cubeba**, *P.B.* *Cubebs.*

The dried unripe fruit of the plant described, cultivated in Java.

Characters and Constituents.—The size of black pepper, globular, wrinkled, blackish, attached to stalks of rather more than its own length (a ready means of distinguishing it from black pepper, which is sessile). Has a warm camphoraceous taste and characteristic odour, resembling that of copaiba but more aromatic. The constituents are *volatile oil* (see below), *cubebin*, an odourless, tasteless, neutral, and inert crystalline body, forming about 2 per cent. of the pepper; amorphous *resin* about 3 per cent.; *cubebic acid*, also amorphous, 1 per cent.; *fixed oil; gum*, about 3 per cent.; and malates of magnesia and lime (Soubeiran and Schmidt).

Action and Uses.—Stimulant, diuretic, and sudorific. Its special stimulant effect on the genito-urinary mucous membrane renders it a serviceable remedy in gonorrhœa and gleet, for which it is almost exclusively employed in this country. It should not be prescribed until after the inflammatory symptoms have subsided, otherwise, like copaiba and turpentine, it is apt to increase the urethral irritation and produce chordee. It may be given with advantage in cystititis and bronchorrhœa.

Dose.—30 to 120 grains of the powder.

2. **Oleum Cubebæ**, *P.B.* $C_{30}H_{48}$. *Oil of Cubebs.*

The oil is obtained in Britain by distilling powdered cubebs with water, or steam between 430° and 480°. The yield is from 6 to 15 per cent. according to the temperature employed.

Characters.—Colourless or pale greenish-yellow, having the odour and taste of cubebs. Boils between 430° and 480°, is polymeric with oil of turpentine. When exposed to cold it deposits rhombic octohedra of *hydrate of cubebene* or *camphor of cubebs*, $C_{30}H_{48},2H_2O$.

Action.—Bernatzik and Schmidt regard the resin and cubebic acid as the essential constituents of cubebs; but those who are familiar with the operation of the crude drug and the essential oil will not, I believe, assent to this view, the general experience being that the volatile oil represents the essential activity of the drug.

Dose.—5 to 20 minims with compound tincture of lavender, on a lump of sugar, or in the form of an emulsion.

3. **Tinctura Cubebæ**, *P.B.* *Tincture of Cubebs.*

Prepared by exhausting 2½ ounces of *powdered cubebs* with 1 pint of *rectified spirit*, and obtaining 1 pint of tincture as directed for tincture of aconite.

Dose.—½ to 2 fluid drachms.

ARTANTHE ELONGATA, *Miquel.* Matico.

This is a small rough-leaved shrub, native of Peru, Brazil, and Venezuela.

Characters.—About 12 feet high; *stems* jointed. *Leaves* shortly petiolate, rough and wrinkled, linear-lanceolate acuminate, pubescent and areolar beneath, from a close network of prominent veins, rugose above. *Spikes* solitary, cylindrical, opposite the leaves. *Bracts* peltate. *Flowers* hermaphrodite. *Style* wanting.—*Ruiz and Pavon, Flor. Peruv.* pl. 57 (*Piper angustifolium.*)

Maticæ folia, *P.B.* *Matico Leaves.*

The dried leaves of the plant above described, imported from Peru.

Characters and Constituents.—From 2 to 8 inches long, veined and tesselated on the upper surface, downy beneath, with an aromatic slightly astringent warm taste, and an agreeable aromatic odour. The leaves contain a small quantity of *volatile oil*, a crystallisable acid called *artanthic acid*, a trace of *tannin*, and a little *resin*.

Action and Uses.—Topically applied, matico leaves are hæmostatic on account of their reticular structure and pubescence, and they are no doubt serviceable as such in the country districts where the plant grows, but they are superfluous here, since cotton wool is a much neater and more efficacious means of arresting hæmorrhage from the surface. Matico has been lauded as an internal *astringent* and *hæmostatic*, and has been recommended in the form of infusion for the relief of mucous discharges. A cup of tea is much more potent.

Infusum Maticæ, *P.B.* *Infusion of Matico.*

Infuse ½ ounce *matico leaves* cut small in 10 fluid ounces of *water* for half an hour, and strain.

Dose.—1 to 4 fluid ounces.

EUPHORBIACEÆ, *Juss.* Spurges.

The Euphorbiaceæ are remarkable for acridity, which is contained in the milky juice; hence some are used as local, and some as general stimulants; others are poisonous in nature. A few secrete volatile oil in the bark, as cascarilla; and others, fatty oil united with acrid principle in their seeds, as in castor and croton oils. The roots of *Jatropha Manihot* secrete fecula and acrid principle, which latter is dissipated by heat.

The *Stillingia sebifera* or tallow-tree is cultivated very extensively in some parts of China. It is valued for the white sebaceous matter—a true *vegetable tallow*—that envelopes its seeds.

EUPHORBIA RESINIFERA, *Berg.* The Resin-bearing Euphorbium.

This is a leafless Cactus-like plant, native of Morocco, and growing about the bases of the Atlas range.

Characters.—*Stems* ascending about 8 feet high, quadrangular, each side measuring about 1 inch, the angles furnished with pairs of simple horizontal spines ¼ inch long. *Inflorescence* terminal; *peduncle* 3-flowered, the central flower sessile. *Flowers* collected into monœcious heads, composed of one female and numerous males. *Involucre* campanulate, with 5 divisions and 5 alternate glands. *Male*—Naked, consisting of a single stamen upon a pedicel, intermixed with scales, surrounding the female. *Female*—A single pistil. *Styles* 3. *Stigmas* bifid. *Seeds* solitary, pendulous. *Fruit* tricoccous; *carples* compressed and keeled; *dehiscence* loculicidal.—*Berg und Schmidt, Offizinelle Gewächse*, iv.

Euphorbium was employed by the early Greek physicians, and is noticed by the Arabs by the name *Furfioon.*

The identification of this plant is due to Berg. The green fleshy branches yield, on incision, an abundant flow of the acrid milky juice which characterises the genus. It is allowed to dry on the stem, and is then collected, and constitutes **Euphorbium resin.**

Characters and Constituents.—Euphorbium is in irregularly-shaped tears, usually pierced with one or with two diverging holes, made by the double prickles of the plant on which it had dried. These sometimes remain in the holes. The colour is of a dull yellowish-white. It is friable, with little odour, but the dust causes violent sneezing and irritation to the eyes, and if inhaled, violent irritation of the respiratory passage and spasms of the larynx; it is very irritant to whatever part it is brought in contact with, and the taste is, after a short period, acrid and burning.

According to Flückiger, 100 parts contain 38 of amorphous *resin* $C_{20}H_{32}O_4$, 22 of *euphorbon* $C_{26}H_{44}O_2$, 18 of mucilage, 12 of malates chiefly of sodium and calcium, and 10 of inorganic matter. The intense acridity of the drug is due to the amorphous resin; it is soluble in rectified spirit. Euphorbon is but sparingly soluble in rectified spirit, requiring about 60 parts, but is freely soluble in it at a boiling temperature, and in æther, chloroform, and glacial acetic acid; it forms colourless, tasteless, inodorous crystals, and is allied to *lactucerin*, a constituent of lettuce (*Flück. Pharmacograph*, p. 504).

Action. Uses.—A powerful irritant. It produces incessant sneezing, and even bloody discharges, and causes ophthalmia if blown into the eyes. An acrid emetic, cathartic, and rubefacient. It is unfit for internal use.

Antidotes.—Oil, emollient drinks, oleaginous enemata.

CROTON ELEUTERIA, *Bennet.* Cascarilla.

This is a close growing shrub or small tree, native of the Bahamas. and the thickets of Jamacia and other West Indian islands.

Cascarilla was first made known by V. Garcias Sabat in 1692. The name, signifying a little bark, is applied by the Spaniards to a variety of barks.

Characters.—*Branches* and *twigs* angular, rather compressed, striated, downy, ferruginous. *Leaves* stalked, alternate, ovate, with a short but obtuse point, green on the upper surface, silvery and densely downy beneath. *Racemes* axillary and terminal, branched. *Flowers* monœcious; *calyx* 5-parted. *Males* uppermost and smaller; *petals* 5; *stamens* 10 or 12. *Females* below, few, and on short stalks; *petals*, none. *Ovary* roundish. *Styles* 3, bifid. *Stigmas* obtuse. *Capsule* roundish, minutely warted, about the size of a pea, with 3 furrows, 3 cells, and 6 valves.—*Bennett, Jour. Proceed. Lin. Soc.; Pharm. Journ.* 2d ser. vol. iv. p. 150.

1. Cascarillæ Cortex, *P.B.* *Cascarilla Bark.*

The bark of the above described tree, from the Bahama islands.

Characters and Constituents.—In quills, 2 or 3 inches in length and from 2 to 5 lines in diameter, dull brown but more or less coated with a white crustaceous lichen (*Verrucaria albissima*), breaks with a short *resinous fracture*, has a warm and bitter taste, and emits a fragrant odour when burned.

The bark yields about 1 per cent. of *volatile oil* of agreeable odour, isomeric, according to Gladstone, with oil of turpentine, 15 per cent. of *resin*, a portion of which is acid and soluble in alkalies, a little *gum*, *tannin*, and *cascarillin*, $C_{12}H_{18}O_4$, the bitter principle of the bark. It forms minute prisms, sparingly soluble in water and chloroform, but freely soluble in æther and hot alcohol. It is a neutral substance.

Substitutes.—A bark without bitterness and aroma, but otherwise resembling cascarilla, has been lately met with. Its tincture does not become milky on the addition of water. Mr Holms suggests that it is derived from *Croton lucidus*. Copalchi bark, the produce of *Croton niveus*, is in long quills thicker than cascarilla bark; it closely resembles the latter in its properties.

Action. Uses.—Stimulant tonic; has been considered febrifuge, and may be advantageously prescribed with cinchona. It is chiefly employed in dyspepsia and in other complaints requiring a warm tonic. It is the essential ingredient in fumigating pastiles.

Dose.—10 to 30 grains of the powder, with carbonate of soda or in milk.

2. **Infusum Cascarillæ**, *P.B.* *Infusion of Cascarilla.*

Infuse 1 ounce of the *bark* in coarse powder in 10 fluid ounces of boiling *water* for an hour, and strain.

Dose.—1 to 2 fluid ounces.

3. **Tinctura Cascarillæ**, *P.B.* *Tincture of Cascarilla.*

Prepared by exhausting 2½ ounces of bruised *cascarilla bark* with 1 pint of *proof spirit*, and obtaining 1 pint of the tincture in the manner prescribed for tincture of aconite.

Dose.—1 to 2 fluid drachms.

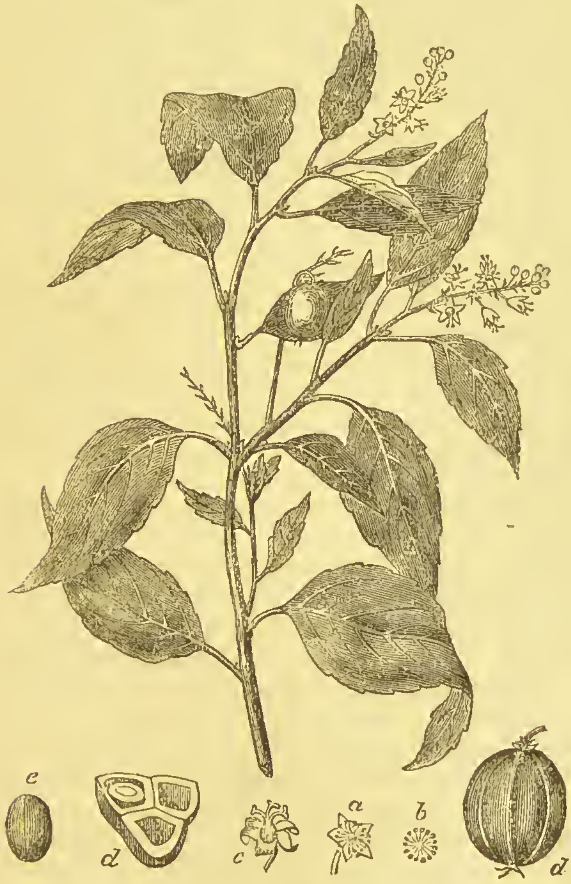

Fig. 68.
Croton Tiglium, female plant. *a*, male flower; *b*, stamens; *c*, female flower; *d d*, fruit; *e*, seed.

CROTON TIGLIUM, *Linn.* **The Croton Oil Tree.**

This is a small tree indigenous to Bengal, Ceylon, and the Malabar coast.

Characters.—15 to 20 feet high, the young branches smooth and roundish. *Leaves* oval-oblong, acuminate, 3–5 nerved, with shallow glandular serratures, thin, membranous, with 2 glands at the base, the younger leaves covered with minute stellate scattered hairs. *Petioles* short, somewhat angular, with a few stellate hairs when young. *Stipules* 2, subulate, minute. *Racemes* terminal, erect, simple, male at apex, female single, below. *Flowers* downy. *Male—Calyx* 5-cleft. *Petals* 5 lanceolate, and woolly. *Stamens* 15 to 20, woolly at base, distinct. *Female—Calyx* 5-cleft, permanent. *Styles* long, bifid. *Capsules* oblong, obtusely triangular, the size of a hazel nut, closely covered with minute stellate hairs; the cells completely filled with the solitary seeds.—*Steph. and Church, Med. Bot.* pl. 4.

The seeds are about ½ an inch in length and ¼ inch broad, oblong, rounded, and a little flattened on one surface—the ventral, along which is the raised raphe The dorsum and sides are also furnished with a crested line, thus giving a sub-prismatic form to the seed. The surface is dullish, or only slightly polished, of a cinnamon-brown colour. When scraped, the black brittle testa is discovered. On removing this, the kernel is found enveloped in a delicate silk-like membrane (*tegmen*). The kernel is composed of oily albumen nearly separated into two plano-convex masses by the embryo, the thin oblong veined cotyledons of which lie in the axis of the albumin, with their edges very near its surface; the radicle lies at the thick end of the seed.

1. **Oleum Crotonis,** *P.B. Croton Oil.*

The oil expressed from the seeds above described. The yield is from 50 to 60 per cent.

Characters and Constituents.—Brownish-yellow, slightly viscid, odour slightly rancid, taste at first bland, but leaving a burning acrid impression in the mouth and fauces, persisting with undiminished intensity for many hours. It is composed of the ordinary fatty acids, and the following volatile ones:—acetic, butyric, and valerianic; *tiglinic acid*, $C_5H_8O_2$, which forms about ⅛ of the weight of the volatile constituents; it is metameric with angelic acid; and *crotonic acid*, $C_4H_6O_2$. The irritant principle has not been isolated.

Substitutes.—The seeds of *Croton oblongifolius* (Roxb.), a small tree common in the neighbourhood of Calcutta, and those of *C. Pavanæ*, a native of Assam, and those of *C. polyandrum*, are employed as purgatives, and may be sometimes substituted for the more powerful seeds of *C. Tiglium.*

Action and Uses.—A violent irritant purgative. 30 minims caused profuse choleraic purging, collapse, and death in the course of 10 hours (Dr Greenhow, *Med. Tim. and Gaz.* 1866, p. 142). In medicinal doses it produces free purging in the course of one or two hours. Its action is said to be uncertain; but this may be attributed to a deterioration of the oil, which is usually kept several years in stock. On account of the smallness of the dose and the rapidity of its action, croton oil is a very useful remedy in coma, tetanus, and the like, where the patient is unable to swallow; and in phrenitis, where a strong counteraction is required. It is also useful in constipation, when, after the lower bowel has been emptied by enemata, milder purgatives fail. Applied externally, it causes inflammation of the skin, attended by a copious pustular eruption. This action is sometimes induced as a counter irritant.

Dose.—$\frac{1}{2}$ to 1 minim, dropped into the mouth when the patient cannot swallow; in the form of pill in other cases, or in mixture with castor oil.

2. **Linimentum Crotonis**, *P.B.* *Liniment of Croton Oil.*

A mixture of 1 fluid ounce of *croton oil* and 3½ fluid ounces each of oil of *cajuput* and *rectified spirit.*

Action and Uses.—A strong counter irritant, producing, when freely rubbed upon the skin, a copious eruption of pustules. The action is attended with considerable smarting. It is unsuited for very delicate persons, and where there is a tendency to hectic. It is chiefly employed in active congestion of the lungs preceding or accompanying tubercular deposit. It is also applied to the neck in laryngitis, and to the joints in chronic rheumatism or synovitis.

RICINUS COMMUNIS, *Linn.* Castor Oil Plant.

This plant appears to be the gourd, or the plant so translated, in Jonah iv. 6, 7, 9, 10. (See *Kikayon*, in Bibl. Cycl. ii. p. 203.) It is also the κικι or κρότων of Dioscorides, and its oil has been employed in medicine from the earliest times by Hindoos, Egyptians, Greeks, and Arabs. The Greek names are taken from the insect called the tick (in Latin *ricinus*), which the seeds resemble.

Different opinions are held respecting the number of species belonging to this genus; but several varieties have no doubt been raised to the rank of species. These are found in Java and throughout India. One has been named *R. europæa*, but it must have been introduced from the East, and is annual because unable to withstand the cold of winter. The common species may be seen in India, especially at the borders of fields, with stems of considerable thickness, and attaining a height of sixteen to twenty feet, and surviving for many years. The oil is valued as a medicine and for burning, and the leaves are used for feeding the Arendy silk-worm. The plant is a native of India, and is cultivated in many countries.

Characters.—*Root* perennial or annual, long, thick, and fibrous. *Stems* (fig. 69) round, thick, jointed, channeled, hollow, glaucous, of a purplish-red colour upwards. *Leaves* large, palmato-peltate, deeply divided into lanceolate, serrated segments, on long, tapering, purplish petioles, with glands at the apex of the petiole. *Flowers* monœcious, in terminal panicles, the lower male, the upper female, all articulated with their peduncles, and sometimes supported by biglandular bracts. *Calyx* 3–5 cleft, valvate. *Petals* wanting. *Male*—*Stamens* numerous, with the filaments branched (*a*) and united below, with the distinct globose cells of the anthers (*b*). *Female*—*Style* 1. *Stigmas* 3, bipartite (*c*), plumose, coloured red. *Capsule* tricoccous, covered with spines, 3-celled (*d*); cells 1-seeded. *Seeds* pendulous, elongated, ovate, convex externally, somewhat flattened on the inside, of a pale grey colour, but marbled with darker colours (*e*). The seed is covered by a thin, coriaceous, smooth seed-coat, composed of two layers; at its upper end is observed the fleshy swelling which has been termed *strophiole*, with a delicate white membrane investing the kernel, which is large, oleaginous, and consists of albumin, containing in the middle a large leafy embryo (*f*).—*Bot. Mag.* pl. 2209.

Castor oil seeds are larger and flatter than those of the croton oil plant; they are also free from the obscure ridges which mark the surface of the latter, and the outer surface of the shell is polished and beautifully veined with black or reddish-brown streaks on a yellowish-brown ground. The internal structure of the seed is identical with that of *Croton Tiglium.*

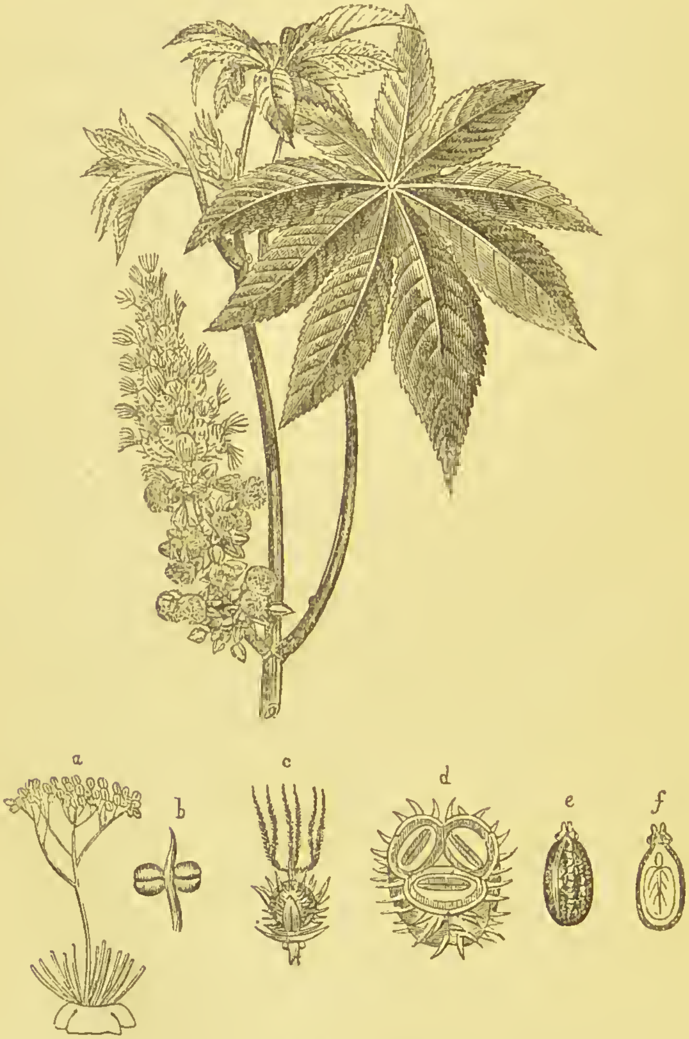

Fig. 69.—*Ricinus communis.*

Oleum Ricini, *P.B.* *Castor Oil.*

The oil expressed from the seeds of the plant described. Imported chiefly from Calcutta.

The kernels should be carefully separated from the husk, and pressure without heat should be employed. The seed contains about 50 per cent. of fixed oil, 20 per cent. of albumin, 2·2 per cent. of sugar and mucilage, and 18 per cent. of cellulin (Fleury). The acrid purgative matter has not been isolated. It appears that the oil contains only the smaller portion of it; for the whole seed,* or the oil extracted by alcohol, is at least twice as powerful as that obtained by simple expression of the separated kernel at the ordinary temperature of the air. The seeds yield to boiling water rectangular prisms and plates of *ricinine* (Tuson), which, according to Warner, is an acid substance. The oil may be extracted from the seeds by decoction in water, or by expression, with or without the aid of heat, and by the agency of alcohol. Sometimes the oil is boiled with water to dissolve out the mucilage and to coagulate the albumin. Dr Christison sums up the result of various papers (by Wright, Boudron, Henry, Bussy, and Guibourt) by stating—that by simple expression a mild oil of excellent quality may be extracted alike from the small and large varieties of the seed: that when so prepared it is apt to become sometimes rancid, but may be prevented from doing so if heated to about 200°, when its albumin is coagulated and detached: that the embryo is scarcely more active than the albumin of the nucleus, and that the husk and perispermal membrane are inert: that if the seeds be boiled in the Eastern way, without first roasting them or driving off the residual water from the oil by heat, an oil of fine quality is obtained, which keeps well, but is probably not quite so active: that the active part of the oil is apparently volatised during decoction with water, so that long ebullition may materially impair its energy: and that if the seeds be roasted before being expressed, or the oil be exposed to a considerable heat, as in the American process, peculiar products are apt to be engendered, which greatly increase the acridity.

Characters.—Very viscid, colourless, or pale straw-yellow; sp. gr. about 0·96. If not rancid, it has a rather pleasant nutty flavour, leaving a faint impression of acridity. Miscible in all proportions with alcohol and glacial acetic acid, and entirely soluble in two volumes of rectified spirit. It does not solidify at 0°. Exposed to the air it slowly dries up to a varnish. When saponified, castor oil yields palmitic and ricinoleic acids—the latter having the composition $HC_{18}H_{33}O_3$. Peroxyde of nitrogen converts it into a solid crystalline isomeric fat, *ricinelaidic acid*. Treated with ammonia, castor oil yields a solid crystalline amide, *ricinolamide*, $C_{18}H_{35}NO_2$.

Action and Uses.—Castor oil, whether injected into the veins or taken into the stomach, passes off by the intestinal canal with a considerable quantity of water, and thus acts as a mild but very sure hydragogue purgative. It is a mild irritant to the mucous membrane, and rarely produces griping. It does not derange the digestive function of the alimentary canal, as stronger aperients do; and hence it is the most suitable aperient for all conditions, and is admirably suited for infants and very delicate persons. In irritable diarrhœa from the presence of indigestible matter, and in the constipation which follows enteric fever, it is also an appropriate remedy. The great certainty of its action, together with advantages derived from the local effects of the oil in facilitating the movements of scybala over the mucous membrane, render castor oil one of the most efficient, and at the same time the safest, remedy that we possess for the relief of obstinate constipation. In these cases large doses may be given, and the action aided, if necessary, by the addition of a drop of croton oil.

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* Dr Royle was once called in a great hurry to the hospital-boat when proceeding with a battalion of artillery up the Ganges, with the statement that several men had been poisoned or seized with cholera. The men had been picking and eating "Indian filberts," as they called the castor oil seeds. The majority recovered rapidly; but three of them suffered severely, and were not discharged from hospital for some time.

Dose.—For infants, a small teaspoonful; for young children, from 1 to 2 fluid drachms; for adults, from ½ to 1½ ounce. It may be taken floating on milk, orange wine, or brandy diluted with a little water.

ROTTLERA TINCTORIA, *Roxb.* The Kamala Tree.

Common in hilly districts of India, ascending to a height of 5000 feet. Found also in the Philippines, China, Australia, Arabia, and Abyssinia.

The powder obtained from the fruit of this tree has long been known in India as producing a red dye called "Wurrus." The tree was named by Roxburgh after Dr Rottler, an eminent Danish missionary, in 1798.

The Arabian physicians mention it as early as the tenth century, under the name *kanbil* or *wars*. Ibn Khurdadbah, an Arab geographer living A.D. 869–885, states that "from Yemen come striped silks, ambergris, *wars*, and gum." *Wars* is described as "a reddish-yellow powder, like sand, which falls to the ground in the valleys of Yemen, and is a good remedy for tapeworm and cutaneous diseases."—(*Journ. Asiatique*, v. 295, quoted by Hanb. and Flück. *Pharmacographia*, p. 515.)

Characters.—Tree or shrub 10 to 15 feet high. *Leaves* 3-ribbed, alternate, oblong, pointed, entire 4 to 8 inches long. *Flowers* diœcious in terminal panicles. *Males—Calyx* 2-cleft. *Corolla* 0. *Stamens* 30 to 40. *Females—Calyx* 3-5 toothed. *Corolla* 0. *Ovary* ovate. *Styles* 3-feathered. *Capsule* roundish, tricoccous, the size of a small cherry covered on the outside with minute, sessile, roundish, semi-transparent glandular bodies, of a bright-red colour.—*Roxb. Coromond*, plate 168.

The fruit ripens in the spring, when it is gathered, and the red powder brushed off and preserved for use.

Kamala, *P.B.* *Kamala.*

A powder consisting of the minute glands that cover the capsules of the plant above described. Imported from India.

Characters and Constituents.—A fine granular mobile powder of a brick-red colour, which ignites with a flash if blown across a flame. It is with difficulty mixed with water, which has little or no action on it even at a boiling heat. Alcohol, æther, chloroform, benzol, acetic acid, and the caustic alkalies speedily deprive them of colour, and form rich saffron-coloured solutions. Moistened with a drop of ammonia, and magnified about 200 times, the granules have the appearance of rounded mulberries. They are round flattened masses of cells slightly umbilicated, and sometimes presenting a short stalk. The cells of which they are composed are cylindrical or club-shaped, and radiate from a central axis; before the grains are thoroughly moistened the mass of cells is seen to be enveloped in a structureless membrane separated from the cells, but the latter soon swell out and meet it, and it then presents a reticulated appearance externally, owing to the approximation of the outer ends of the contained cells. The granules measure about the $\frac{1}{200}$ of an inch, and the constituent cells about the $\frac{1}{2000}$ of an inch in width. Besides the granules, the moistened powder presents a number of stellate masses of short vegetable hairs. It should be free from sand or earthy impurities.

Kamala yields to alcohol or æther about 80 per cent. of reddish-yellow *resin*. Dr Anderson of Glasgow found that a strong ætherial solution of Kamala solidified to a mass of granular crystals, which he called *Rottlerin*, and gave it the formula $C_{22}H_5O_6$. Indifferent specimens of Kamala do not thus furnish crystals. Leube separated the resin into two kinds, which differ only in degree of solubility and in the temperature at which they fuse. Both dissolve in alkalies without change. He gives to the one the formula $C_{30}H_9O_8$, and to the other $C_{16}H_6O_{10}$.

Kamala also contains traces of tannic acid, gum, and volatile oil. When heated it emits an aromatic odour, and after incineration leaves 1·37 per cent. of ash. The resin is the essential constituent.

Action and Uses.—Drs Mackinnon and Anderson of India found that Kamala is speedily purgative, occasionally causing a little nausea and griping. A dose of 180 grains usually purges five or seven times, and in feeble persons twelve or fourteen times. They both found it very efficacious in the expulsion of tænia for which purpose it has been introduced into the Pharmacopœia.

Dose.—30 to 110 grains, given in a little strong brandy and water. Dr Anderson recommends a tincture as being milder in its action.

MANIHOT UTILISSIMA, *Pohl.* The Cassava or Tapioca Tree.

Jatropha Manihot, Linn. *Janipha Manihot*, Humb. and Bonpl.

This plant is a native of Brazil. It is largely cultivated for its starch in South America and the West Indies.

Tapioca is first mentioned by Piso in his Nat. Hist. of Brazil, p. 52.

Characters.—A *shrub*, 4-6 feet high. *Root* large, tuberous, fleshy, and white, with a milky, acrid, poisonous juice. *Leaves* palmate, 5–7 parted, smooth, glaucous beneath; segments lanceolate, quite entire. *Flowers* axillary, racemose, monœcious. *Calyx* campanulate, 5-parted. *Petals* none. *Stamens* 10; filaments unequal, distinct, arranged around a disk. *Style* 1; *stigmas* 3, consolidated into a rugose mass.—*Adr. de Juss and Hooker; Bot. Mag.* plate 3071.

Of this plant there are two distinct varieties—one known as the *Sweet Cassava*, the other as the *Bitter*.

The *sweet cassava* is about 4 feet high, the root about a foot in length, and seven or eight inches in circumference, of a light-brown colour. It is very juicy, something resembling chestnuts in taste, and is used as a vegetable either boiled or roasted. But much of it is employed in making a fermented liquor, the root being scraped into a pulp, from which the liquor is squeezed. This is called *Piwarry*, and is drunk by the Indians as an intoxicating liquor (Mr Gill).

The *bitter cassava* is about six feet high, the leaves of a darker green, and the stem of a dark-brown colour; the roots are longer in coming to maturity, and much larger, being about twenty inches in length, and ten in circumference. The juice is acrid and poisonous. It is cultivated for making the tapioca of commerce and cassava bread. The latter is made by grating the fresh roots, squeezing out the juice, and then baking into cakes on an iron plate. *Tapioca* (cassava starch or Brazilian arrowroot) is prepared by beating the root into a pulp, washing it with cold water, and then allowing the starch to subside from the milky fluid which flows from it. Being then dried on heated plates, it becomes of a granular form. By the washing and heating, the poisonous matter, being both soluble and volatile, is dissipated.

The irregular grains of which tapioca consists are about the size of large shot, whitish, and, like other kinds of starch, without odour or taste. The starch grains are very minute, but regular and characteristic in form (see p. 317.) Tapioca has the general characteristics of starch, of which it is a pure form.

Action. Uses.—Dietetical, demulcent. Much approved of as a diet for the sick-room and for infants at the time of weaning.

ARISTOLOCHIACEÆ, *Lindl.* Birthworts.

Apetalous Exogens with an adherent calyx, a 3–6 celled ovary, indefinite ovules, and albuminous seeds.

ARISTOLOCHIA SERPENTARIA, *Linn.* Virginia Snake-Root.

Several species of Aristolochia were employed by the ancients, and still are so on the Continent, as well as in Asia. The officinal species was probably first brought to notice as a *Snake-root* by settlers in America. It is first mentioned in Johnson's edition of Gerard's Herbal. It is a native of the Middle, Southern, and Western States of North America.

Characters.—*Rootstock* perennial, roundish, with numerous root-fibres; throwing up several herbaceous stems 8 to 10 inches high, slender, flexuose, jointed at irregular distances, often of a reddish colour at the base. *Leaves* alternate, shortly petioled, cordate, acuminate, smooth, and of a pale yellowish-green colour, a little downy beneath. The peduncles are produced on the stem, but near the root, nearly unifloral, with one or more bracts. *Perianth* tubular, contorted like the letter S, inflated at its two extremities, the throat surrounded by an elevated ridge, and the border expanded into a broad irregular margin, forming an upper and under lip. *Anthers* 6, attached to the sides of the fleshy *style*, which is situated in the bottom of the perianth, covered by the spreading 6-lobed *stigma.* *Capsule* obovate, 6-angled, 6-celled with many flat seeds. The root is collected in Western Pennsylvania and Virginia, in Ohio, Indiana, and Kentucky.—*Nees von E.* 143; *Steph. and Church.* pl. 180.

American writers state that the roots of two other species, *A. tomentosa* and *A. hastata*, are also collected. The latter is closely allied to *A. serpentaria*, the other climbs to the tops of tall trees; but their roots are said scarcely to differ from those of *A. serpentaria.* The root of *A. reticulata* has lately been introduced into commerce as Texan or Red River snake-root.

1. **Serpentariæ Radix**, *P.B.*. *Serpentary Root.*

The dried rhizome of *A. serpentaria.* From the southern parts of North America.

Characters and Constituents.—A small roundish rhizome, with a tuft of numerous slender rootlets, about three inches long, yellowish, of an agreeable terebinthine and camphoraceous odour, and a warm, very bitter, terebinthine taste. It contains about ½ per cent. each of volatile oil and resin, an amorphous bitter principle, a little tannin, sugar, and mucilage.

Action and Uses.—Serpentary is a stimulant tonic, diaphoretic, and stomachic, and in large doses slightly irritant, producing nausea, flatulency, a disposition to diarrhœa, increased fulness of the pulse, congestive headache, and disturbed sleep. It was long a reputed remedy against the bite of the rattlesnake, thence called *snake-root*, and also against rabies; but it has no special power in either case. It is employed as a stomachic in gastric atony, and as a diffusible stimulant tonic in diphtheria and low continued fevers. It is an excessively nauseous bitter; and I have on this account usually given it in these diseases by the rectum.

Dose.—10 to 20 grains; but it is usually given in one of the following forms:—

Pharmaceutical Uses.—An ingredient of Tinctura cinchonæ composita.

2. **Infusum Serpentariæ**, *P.B.* *Infusion of Serpentary.*

Prepared by infusing ¼ ounce of the *bruised root* in 10 fluid ounces of *water* for two hours, and straining.

Dose.—1 to 2 fluid ounces.

3. **Tinctura Serpentariæ**, *P.B.* *Tincture of Serpentary.*

Prepared by exhausting 2½ ounces of *serpentary root in coarse* *powder* with 1 pint of *proof spirit*, and making 1 pint of tincture in the manner prescribed for tincture of aconite.

Bruised and not powdered root should have been ordered; for the root cannot be coarsely powdered without drying, and it cannot be sufficiently dried without some loss of its volatile constituents.

Dose.—½ to 2 fluid drachms.

Asarum Europœum, Linn. *Asarabacca.*—The leaves of this indigenous plant are possessed of irritant properties, and have been used as an errhine.

THYMELACEÆ, *Juss.* Daphnes.

Daphnal Exogens, apetalous or polypetalous. *Calyx* imbricated. *Anthers* bursting longitudinally. *Ovule* solitary, suspended. *Bark* acrid, and remarkable for its tenacity.

DAPHNE MEZEREUM, *Linn.* Mezereon.
D. LAUREOLA, *Linn.* Spurge Laurel.

Both of these plants are indigenous; the former is commonly cultivated as a garden shrub.

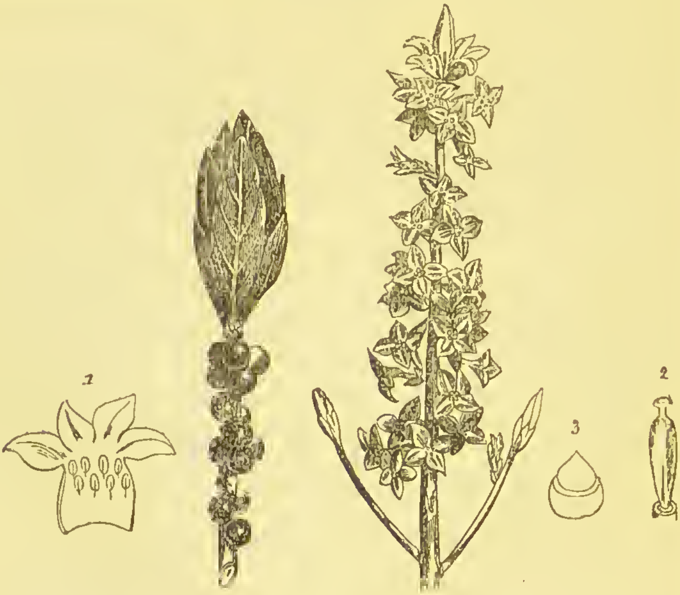

Fig. 70.—*Daphne Mezereum.*

D. Mezereum is supposed to be included with *Daphne oleoides* under the χαμέλαια of Dioscorides. It is called *Mazrioon* in Persian works on Materia Medica, and *Khamela* is assigned as its Greek name.

D. Mezereum (fig. 70) is a small shrub. *Leaves* lanceolate, tapering below, smooth, evergreen. *Flowers* arranged in a spike-like manner, appearing before the leaves, rose-coloured. *Perianth* 4-fid, segments ovate-acute, tube hairy. *Stamens* 8, inserted in the tube of the perianth in two rows (1).

Ovary oval, oblong, with a short style and peltate stigma (2). *Berry* bright red, fleshy, 1-seeded (see 3, where some of the sarcocarp has been removed, to show the seed).—*Nees von Esen.* 125; *Steph. and Church,* pl. 65.

D. LAUREOLA, F. *Garou,* is a small shrub, 1–3 feet high. *Leaves* spathulate, entire, smooth, evergreen. *Flowers* in axillary racemes, yellowish-green, drooping, funnel-shaped. *Berries* black.—*Eng. Bot.* vol. ii. pl. 119.

All parts of these plants are more or less acrid. Martius found the fruit contained more than 40 per cent. of a fatty vesicating oil. This appears to become resinous in the bark. The berries, according to Pallas, are used as a cathartic; in large doses they are poisonous.

1. **Mezerei Cortex,** *P.B. Mezereon Bark.*

The dried bark of the plants above described.

Characters and Constituents.—In strips or quilled pieces of various lengths, tough and pliable; olive-brown on the surface, white, satiny, and stringy-fibrous within; odour faintly nauseous; taste hot and acrid.

The acrid principle is a *resin;* the bark also contains a little *volatile oil,* which is very irritant, and a neutral non-volatile glucoside called by Vauquelin *Daphnin.* According to Zwenger, it is composed of $C_{31}H_{34}O_{19}$; boiled with dilute sulphuric acid, it yields colourless prisms of *daphnetin,* $C_{19}H_{14}O_9$. These bodies appear to be destitute of active properties.

The properties of Mezereon bark are imparted to water, alcohol, vinegar, and oils.

Action and Uses.—A piece of the bark moistened with vinegar and applied to the skin and renewed will produce a blister. Guibourt recommends an ointment as a substitute for savine ointment. Internally it is a stimulant, diaphoretic, and diuretic: in large doses it is irritant, causing nausea and purging. As an ingredient of compound decoction of sarsaparilla (60 grains in 1 pint), it is employed in chronic skin disease, and as a constituent of compound mustard liniment it is used as a rubefacient and epispastic.

2. **Extractum Mezerei æthereum,** *P.B. Æthereal Extract of Mezereon.*

Preparation.—Macerate 1 pound of *Mezereon bark,* cut small, in 6 pints of *rectified spirit* for three days, with frequent agitation; strain and press. Macerate the *Mezereon* for three days more in 2 pints of *fresh spirit;* strain and press; mix and filter the liquors; distil off the greater part of the spirit, and evaporate the remaining fluid to the consistence of a soft extract. Put this into a stoppered bottle with 1 pint of æther, and macerate for twenty-four hours, shaking frequently. Decant the æthereal solution, distil off a portion of the æther, and evaporate what remains to the consistence of a soft extract.

This process is a heavy one,—8 pints of spirit and 1 of æther! and for what?—a few grains of acrid resin, equal in therapeutical value to so much mustard. We are reminded of the Scotch laird who cut down an ancestral tree to get a bundle of sticks wherewith to boil his kettle. Necessity no doubt prompted the act in this case; but it can hardly be said to have dictated the pharmaceutical process.

Pharmaceutical Use.—An ingredient of Linimentum sinapis compositum, which contains 8 grains in the fluid ounce.

LAURACEÆ, *R. Brown.* Laurels.

This Order is distinguished from Thymelaceæ by the recurved anther valves, and from Nutmegs by the hermaphrodite flowers.

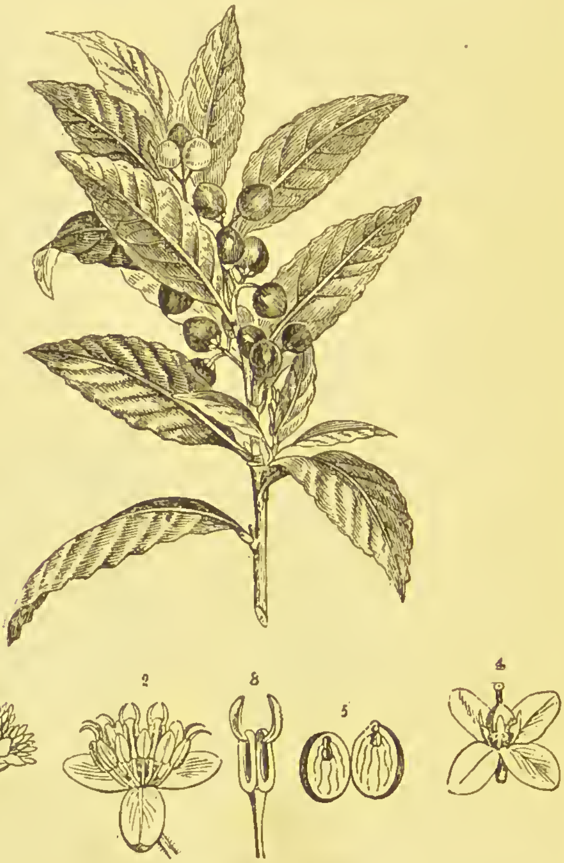

Fig. 71.—*Laurus nobilis.*

LAURUS NOBILIS, *Linn.* The Laurel or Sweet Bay.

This is the Δάφνη of the Greeks. From its leaves having been employed in making chaplets for their gods and crowns for their heroes, it was called *Laurus nobilis* by Linnæus. It is the *ghar* of the Arabs, and probably the *Ezrach* of the Bible. (See *Bibl. Cycl.* i. p. 692.) It is a native of the North of Asia and the Mediterranean regions, and is commonly cultivated in gardens and shrubberies.

Characters.—Evergreen (fig. 71), from 15 to 25 feet high, with dense leafy branches. *Leaves* oblong, lanceolate, acute, wavy at the margin, hairless, with the exception of a fine beard and small pore at the axils of the lower vein. *Umbels* 4-6 flowered (1); axillary, supported by scarious concave scales. *Flowers* diœcious or hermaphrodite, yellowish, dotted with fine glands. *Perianth* 4-parted (2). *Stamens* 12 in 3 rows, the external alternating with the segments of the perianth. *Filaments* each with 2 glands at or above the middle. *Anthers* oblong, 2-celled, all looking inwards, opening with 2 turned-up valves. *Stigma* capitate. *Berry* ovoid, about the size of a field-bean, bluish-black, single-seeded. *Cotyledons* large, oleaginous, convex on the back.—*Nees von Esen.* t. 132.

1. **Lauri folia.**—*Laurel leaves* are not now officinal. They must be carefully distinguished from the poisonous leaves of the *Cherry laurel* (see Cerasus). They have a fragrant odour, and an aromatic, rather bitter taste. These properties they owe chiefly to the presence of a yellow-coloured volatile oil, which may be separated by distillation with water.

2. **Lauri fructus.**—*Laurel Berries* (*hab al ghar* of the Arabs) are oblong, ellipsoid; when dry, of a dark-brown colour, with a wrinkled, friable sarcocarp, covering the two oval fatty cotyledons. They contain a warm, fragrant volatile oil, which may be obtained by distillation with water, and about ¼ of a greenish-coloured fat, which may be separated by expression.

3. **Oleum Lauri expressum**, or *Oil of Bay*, is obtained by pressure, with the aid of heat, both from the fresh and the dry drupes of the bay tree. It is imported from the south of Europe. Like the butter of nutmegs, it contains a volatile oil, elain, and stearin.

Action. Uses.—Aromatic stimulants, but not much used now. The infusion of the leaves is diaphoretic. Oil of bay may be used as a stimulant embrocation.

CINNAMOMUM CAMPHORA, *F. Nees and Ebermair.* The Camphor Tree.

Camphora officinarum, C. Bauh. *Laurus camphora*, Linn.

This is a large and handsome tree with evergreen shining leaves. It flourishes from the eastern provinces of China to the shores of Lago Maggiore. In the island of Formosa it clothes the whole range of mountains from north to south to an elevation of 2000 feet. The fragrant white wood is much used in China for making trunks and cabinets, to preserve articles of clothing from the ravages of the moth. All parts of the tree emit a camphoraceous odour when bruised.

Characters.—*Branches* somewhat lax, smooth, with a greenish bark. *Leaves* alternate, with long petioles, ovate-lanceolate, rather coriaceous, smooth, shining, and bright-green above, paler beneath, triple-nerved, with a sunken gland opening by a pore beneath at the axils of the principal lateral veins. Leaf-buds scaly. *Flowers* small, hermaphrodite, smooth externally, in naked, axillary, and terminal corymbose panicles. *Perianth* 6-cleft, with a deciduous limb. Fertile *stamens* 9, in 3 rows, the 3 inner supported at the base by 2 stipitate compressed glands. *Anthers* 4-celled, opening by as many ascending valves, the three interior looking outwards, the others opening inwards. Three sterile stamens subalternate with those of the second row, three others stipitate, each with an ovate head. *Drupe* situated in the truncate cup-like base of the perianth.—*Nees von Esenb.* 130; *Woodv. Med. Bot.* pl. 155.

Camphor is diffused through all parts of the plant, and is separated from the root, trunk, and branches, which being cut into chips, are boiled in water, and the camphor which separates is then sublimed into inverted copper basins. It is thus obtained in the form of *crude camphor*, chiefly from the province of Fokien in China and the opposite island of Formosa, but some of good quality is also procured from Japan. The Dutch exported from thence into Europe 310,520 pounds in seven years. It is sometimes imported into this country from Batavia. The ordinary crude camphor is in small greyish-coloured, slightly sparkling grains, which by aggregation form greyish crumbling cakes, with all the properties of purified camphor. This is separated from impurities by being mixed with lime and sublimed into thin glass vessels of a certain shape, which being afterwards cracked, the camphor is obtained in a bell-shaped, concavo-convex cake about three inches thick with a hole in its middle.

1. **Camphora,** *P.B.* *Camphor.* $C_{10}H_{16}O$.

A concrete volatile oil, obtained from the wood of the tree described. Imported in the crude state from China and Japan, and purified by sublimation in this country.

Characters and Tests.—White, translucent, tough, and crystalline; sp. gr. 0·996; has a powerful penetrating odour and a pungent bitter taste, followed by a sensation of cold; floats on water, volatilises slowly at ordinary temperatures, and is deposited in hexagonal plates or prisms; sp. gr. of the vapour, 5·3; soluble in 1300 parts of water, but very soluble in rectified spirit, æther, chloroform, acetic acid, and the volatile and fixed oils. It melts at 288°, boils at 400°, and entirely sublimes (proving the absence of impurity). It burns with a bright clear flame.

If camphor be distilled with phosphoric anhydride it is resolved by the elimination of a molecule of water into cymol ($C_{10}H_{14}$), thus: $C_{10}H_{16}O = H_2O + C_{10}H_{14}$. Cymol is often met with as a constituent of essential oils. When heated with ten times its weight of nitric acid, camphor is slowly oxydised into camphoric acid ($H_2C_{10}H_{14}O$), which is crystalline dibasic and inodorous. Heated under pressure with half its weight of caustic potash dissolved in alcohol, camphor is converted into Borneo camphor (see Dryobalanops) or camphol ($C_{10}H_{18}O$) and camphic acid ($HC_{10}H_{15}O_2$).

Action and Uses.—The action of camphor is misunderstood, for it is assumed to be anodyne and stimulant in the small doses usually prescribed, and it has therefore been advocated as a serviceable remedy in fever. Again, poisonous effects have been frequently attributed to doses insufficient to cause them, because in patients predisposed to such attacks, hysterical or epileptic symptoms have now and then occurred coincidently with its administration. The physiological effects of camphor are induced in delicate subjects by a dose of 20 or 30 grains in solution,—a quantity which I have frequently given to epileptic and other patients (see *Practitioner*, Oct. 1872, p. 210) once or twice a day for a week or two at a time. The immediate effects are giddiness, somnolency, and lethargy, with a pleasant feeling of warmth under the sternum, and a slight increase in the force and frequency of the pulse, attended with a rise of 1° or 2° in the temperature of the surface. After continuing for one or two hours these effects disappear, and are followed by languor, which is the only appreciable result of the continued use of the medicine, as it does not interfere in the least with the natural functions. After larger doses, 100 to 200 grains, delirium from which the patient is immediately recalled, and diminution in the force of the pulse and in temperature are the chief symptoms, and recovery is established after a few hours. Less than 4 or 5 grains fail to produce any appreciable effects. Camphor appears to be absorbed into the blood and to undergo decomposition in this fluid, or during the process of elimination, for, contrary to the common statements, I have never been able, when giving the large doses above mentioned, to detect the odour of camphor in the breath or in any of the excretions. I have often remarked that the odour of camphor is very speedily destroyed, and it is probably converted by oxydation into odourless camphoric acid. When a warm-blooded animal is confined in an atmosphere of camphor for twenty-four or forty-eight hours it produces at first itching and hyperæmia of the skin, followed by great lethargy of the motor and intellectual functions. There is no apparent discomfort, and the animal soon recovers his vivacity when the camphor is removed. Under the same circumstances, insects are at first excited by the irritant vapour, then feeble, and afterwards torpid, and gradually die. A solution of camphor prevents the development of the lower vegetable organisms, and it is therefore antiseptic. Locally, camphor causes slight irritation and increased vascularity of the part to which it is applied, and the inhalation of its vapour is a popular counter irritant in catarrh. It may be given as a direct stimulant to the mucous membrane in peritonitis, in order to induce a flow of blood from the congested peritoneal membrane. Anaphrodisaic properties are generally ascribed to camphor, but I have failed to observe this effect in a few cases of sexual irritation where I have freely prescribed it. In chordee it is usually prescribed with henbane,—a much more potent remedy, and one which would effectually conceal any action that may be attributed to camphor alone. Strong spirituous solutions of camphor have been recommended in choleraic diarrhœa, and they are no doubt beneficial in promoting by a local stimulant action a more healthy tone in the relaxed blood-vessels.

Dose.—5 to 20 grains, given in the form of emulsion or solution.

Pharmaceutical Uses.—An ingredient of all the liniments except Linimentum ammoniæ, L. calcis, L. crotonis, L. opii, and L. potassii iodidi cum sapone; also contained in Tinctura camphoræ composita (1½ grain in 1 fluid ounce), Unguentum plumbi subacetatis compositum, U. hydrargyri comp., and the following:—

2. **Aqua Camphoræ**, *P.B.* *Camphor Water.* 1 part in about 1300.

Preparation.—Enclose ½ ounce of broken *camphor* in a muslin bag, and keep it by means of a glass rod or weight at the bottom of a stoppered vessel containing 1 gallon of *water.* It may be poured off for use after two days.

Dose.—1 to 2 fluid ounces.

3. **Spiritus Camphoræ**, *P.B.* *Spirit of Camphor.* 1 part in 10.

Consists of a solution of 1 ounce of *camphor* in 9 fluid ounces of *rectified spirit.*

Dose.—½ to 2 fluid drachms. ½ drachm will dissolve in a tumberful of tepid water. If this quantity of fluid be too great, the camphor which is precipitated on the addition of water may be suspended in milk, mucilage, or syrup. The spirit may be applied externally as an anodyne and stimulant to chilblains.

4. **Tinctura Camphoræ composita**, *P.B.* (See Preparations of Opium.

5. **Linimentum Camphoræ**, *P.B.* *Camphor Liniment.* 1 part in 5.

This is a solution of 1 ounce of *camphor* in 4 fluid ounces of *olive oil.*

A pleasant stimulant embrocation for neuralgic and rheumatic pains, &c.

Pharmaceutical Uses.—It is a constituent of Linimentum chloroformi, L. hydrargyri, and L. terebinthinæ aceticum.

6. **Linimentum Camphoræ compositum**, *P.B.* *Compound Camphor Liniment.*

Preparation.—Dissolve 2½ ounces of *camphor* and 1 fluid drachm *oil of lavender* in 15 fluid ounces of *rectified spirit*, and add gradually 5 fluid ounces of *strong solution of ammonia*, shaking to form a clear solution.

This is a strong stimulant and rubefacient.

CINNAMOMUM ZEYLANICUM, *Breyne.* The Cinnamon.

A small evergreen tree with shining leaves and panicles of green flowers; native of Ceylon; often growing at an elevation of several thousand feet.

Cinnamon is the *kinnemon* of Exod. xxx. 23 (see *Bibl. Cycl.* ii. p. 210), and the κιννάμωμον of Herodotus, a name which he states the Greeks learnt from the Phœnicians. The name seems derived from the Cingalese *cacynnama* (dulce lignum), or the Malay *kaimanis*, which Mr Marshall says is sometimes pronounced *kainamanis* (see *Antiq. of Hind. Med.* 84 and 141).

Characters.—About 30 feet high. *Root* has the odour of cinnamon, as well as that of camphor, and yields this principle upon distillation. *Twigs* somewhat four-cornered, smooth, shining, and free from any downiness. *Leaves* liable to variation, ovate, or ovate-oblong, terminating in an obtuse point, 3-nerved, reticulated on the under side, smooth, shining, the uppermost the smallest, tasting of cloves. *Panicles* terminal and axillary. *Flowers* usually bisexual, rather silky. *Perianth* (2) 6-cleft, segments oblong, the upper part deciduous. Fertile *stamens* 9, in 3 rows, the 2 inner with 2 sessile glands at the base (6). *Anthers* (4–6) ovate, 4-celled. *Ovary* 1-celled, with a single ovule. *Stigma* disk-like. *Drupe* (or berry) 1-seeded, seated in the cup-like 6-lobed base of the perianth (7). *Seed* large, with large oily cotyledons (8–10); *radicle* above.—*Wight, Icon. Plant. Orient.* pl. 123; *Nees von E.* as *Laurus Cinnamomum*, 128; *Steph. and Church.* pl 121.

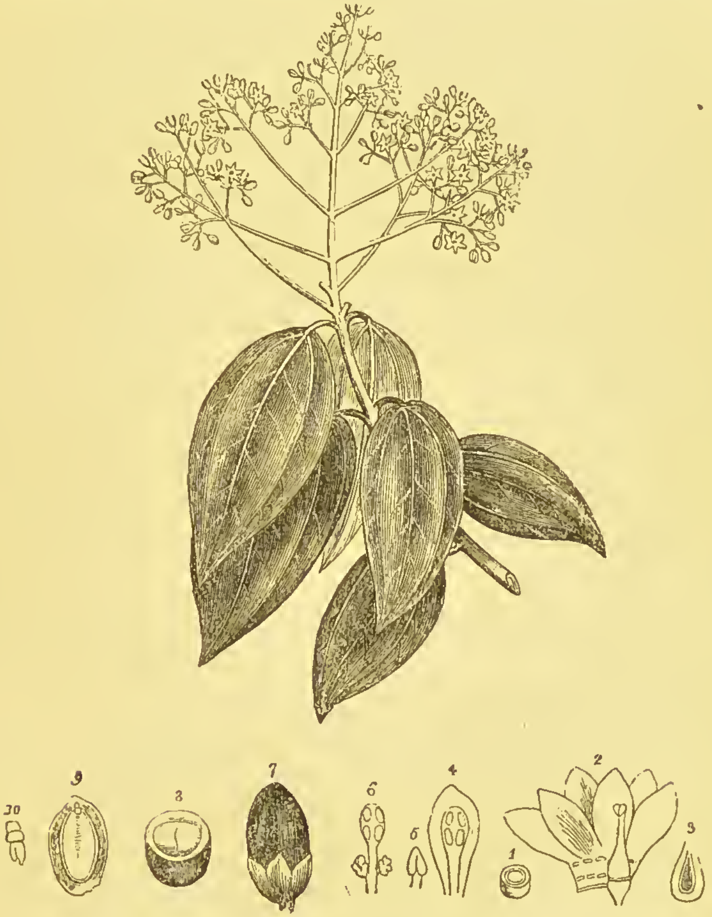

Fig. 72—*Cinnamonmum Zeylanicum.*

Cinnamon is cultivated in plantations situated on the south-west of the island of Ceylon, between Negombo and Matura, where the soil is nearly a pure quartzose sand, the climate damp, showers frequent, and the temperature high and equable (Dr Davy). The plantations are managed in a similar way to our oak coppices, the stems being cut down so as to form "stools," from which the shoots arise. These are cut in May, and again in December, when about two years old and ½ to ¾ inch in diameter, and just as the suberous layer is forming. The bark is divided by longitudinal incisions—of which two opposite to each other are made in the smaller shoots, several in the larger—and then peeled off in strips. After twenty-four hours, the epidermis and the green matter under it are scraped off, after the strips of bark have been placed on a convex piece of wood. The bark soon contracts into the form of quills, which are about forty inches in length, of which the smaller are introduced within the larger ones, forming the ordinary rolls of cinnamon. They are dried first in the shade and then in the sun, and sorted into cinnamon of different qualities, known in commerce as first, second, and third cinnamon. It is imported chiefly from Ceylon; some also from Tellicherry on the Malabar coast, probably grown at Anjárakandy (see Buchanan's *Mysore*, p. 546). Some is also exported from other parts of the Madras Presidency, where it was long since introduced by Dr Anderson and grown at Tinnivelly, &c. (see Roxb. *Fl. Ind.* ii. p. 296). It has been exported from Quilon (see *Cassia*).

The leaves yield a brown viscid essential oil, having the odour of oil of cloves; sp. gr. 1·053. It contains a small quantity of benzoic acid, and composed of a mixture of *eugenic acid* and a neutral oil, $C_{10}H_{16}$ (Stenhouse).

The ripe fruit yields by expression a fatty substance called *cinnamon suet.* Dr Royle supposes this to be the *comacum* of Theophrastus (Rheede, *Hort. Mal.* i. p. 110; *Antiq. of Hind. Med.* p. 546). An essential oil is also obtained from the root. It is lighter than water, yellow, has a mixed odour of camphor and cinnamon, and a strong camphoraceous taste. The root also yields solid camphor.

Ceylon cinnamon of the best quality is in long and slender cylindrical bundles, about forty inches in length, composed of numerous quills.

1. **Cinnamomi cortex,** *P.B. Cinnamon Bark.*

The inner bark of shoots from the truncated stocks of the plant described. Imported from Ceylon, and distinguished as Ceylon cinnamon.

Characters and Constituents.—About $\frac{1}{6}$th to 1 line thick, in closely rolled quills, which are about 4 lines in diameter, containing several small quills within them; light yellowish-brown, with a fragrant odour, and warm, sweet aromatic taste; breaks with a splintery fracture. A decoction of the powdered bark gives only a feeble starch reaction with tincture of iodine.

The essential constituent is *volatile oil* (see oil of cinnamon) which exists in the proportion of $\frac{1}{6}$ to 1 per cent. sugar, mannite, starch, mucilage, and tannic acid. The bark yields 5 per cent. of ash, consisting chiefly of potassium and calcium carbonate (Schätzler).

Varieties and Substitutes.—Three qualities of Ceylon cinnamon are imported, and also several varieties from the Malabar coast; and Dr Wight has ascertained that the cassia of the Indian peninsula is sometimes exported as cinnamon. But the cinnamon plant itself has been introduced into so many places that small quantities are occasionally imported from them, as, for instance, from Cayenne. Some of them are employed for adulterating the superior and more expensive Ceylon cinnamon. The inferior kinds are thicker, and have a greater resemblance to cassia.

Action. Uses.—Aromatic, stomachic, and slightly astringent. It is the type of aromatics, the most grateful of condiments. It is much used as an ingredient of chocolate. The powder in doses of 5 to 20 grains checks nausea and relieves flatulence and cramps. The following preparations illustrate its uses:—

Pharmaceutical Uses.—A constituent of Acidum sulphuricum aromaticum, Decoctum hæmatoxyli, Infusum catechu, Pulvis catechu compositus, P. cretæ comp., P. kino comp., Tinctura cardamomi composita, T. catechu, T. lavandulæ composita, Vinum opii; and in the preparation of the following:—

2. **Oleum Cinnamomi,** *P.B.* *Oil of Cinnamon.*

The oil distilled from cinnamon bark imported from Ceylon. It is obtained by macerating the powdered rejected bark in a saturated solution of salt, and then distilling. The water which passes over is milky, but the oil soon separates. About 8 ounces are obtained from 80 pounds of recently prepared cinnamon. Some of it is heavier and some lighter than water.

Characters and Composition.—Yellowish when recent, gradually becoming red; sp. gr. 1·035; of a powerful cinnamon odour and flavour, and a sweet aromatic, burning taste. It boils between 428° and 446°.

It is composed of *cinnamyl hydride*, $C_9H_7O,H=132$: and a small proportion of hydrocarbon isomeric with oil of turpentine. The cinnamyl hydride is readily separated by shaking oil of cinnamon with hydropotassic sulphite, when it separates in a crystalline form. At about 100 it is a colourless oil representing the entire sweetness and fragrance of the crude oil, a little heavier than water, oxydises rapidly in the air, and becomes yellow from the formation of solid resin and *cinnamic acid*, $HC_9H_7O_2$. Nitric acid forms with cinnamyl hydride a crystalline compound, which is immediately resolved into its uncharged constituents by the additon of water. Boiled with nitric acid cinnamyl hydride is converted into benzoyl hydride and benzoic acid; boiled with chloride of lime benzoate of lime is formed. Chiozza, indeed, has shown that benzoyl hydride may be converted artificially into oil of cinnamon. When the latter is heated with caustic potash hydrogen is evolved, and cinnamic acid is formed, thus: $C_9H_8O+KHO=KC_9H_7O_2+H_2$. The acid may be precipitated from the cinnamate of potash by the addition of hydrochloric acid.

Cinnamic acid is interesting as being a constituent of many balsams, especially storax, and the balsams of Tolu and Peru. It resembles benzoic acid in appearance, and crystallises from boiling water in brilliant laminæ. It dissolves freely in alcohol, fuses on the application of heat, and sublimes unchanged. The cinnamates are monobasic; those of the alkali metals are soluble and crystallisable. They give a yellow precipitate with salts of iron. When distilled with caustic baryta the acid is converted with the liberation of carbonic anhydride into *cinnamol* or *styrol*, C_8H_8 (see p. 414), which may be regarded as the radical hydrocarbon of the cinnamic series as benzol is of the benzoic, thus: $HC_9H_7O_2 + BaO = BaCO_3 + C_8H_8$.

Action and Uses.—Oil of cinnamon is used as an aromatic stimulant and carminative, usually as an adjunct to pills or tinctures.

Dose.—1 to 5 minims.

3. **Aqua Cinnamomi**, *P.B.* *Cinnamon Water.*

Prepared by distilling 1 gallon of the water from 20 ounces of the bruised bark and 2 gallons of water.

Pharmaceutical Uses.—The aqueous constituent of Mistura cretæ, M. guaiaci, and M. spiritus vini gallici.

4. **Tinctura Cinnamomi**, *P.B.* *Tincture of Cinnamon.*

Prepared by exhausting 2½ ounces of *cinnamon bark* in coarse powder with 1 pint of *proof spirit*, and obtaining 1 pint of tincture in the manner directed for Tinctura aconiti.

Dose.—½ to 2 fluid drachms.

5. **Pulvis Cinnamomi compositus**, *P.B.* *Compound Cinnamon Powder.*

A mixture of equal parts by weight of cinnamon bark, cardamom seed, and ginger, all in fine powder.

Action and Uses.—Stimulant and carminative in diarrhœa and colic. An adjunct to Pilula aloes et ferri, and P. cambogiæ composita to prevent griping.

Dose.—3 to 10 grains.

Other Species of Cinnamomum, yielding *Cassia Bark.*

In the Khasya mountains of Eastern Bengal three species of *Cinnamomum* yield cassia, viz., *C. obtusifolium*, Nees; *C. pauciflorum*, Nees; and *C. Tamala*, Nees and Eberm. The cassia of Southern India and of the islands of the Indian Archipelago is the produce of *C. iners*, Reinw., a plant closely resembling *C. Zeylanicum*; and *C. Cassia.*

The finest cassia, called on the Continent *Chinese cinnamon*, is derived from the Southern provinces of China, Kwangsi, and Kweichan (Dr F. Porter Smith), the species producing it are not ascertained.

Cassia is mentioned by early Greek writers; in the Bible by the name *Kiddah* (κιττώ is one kind of cassia in *Diosc.* i. c. 12). It is translated cassia in Exod. xxx. 24 (see Kiddah and Kinnamon, *Bibl. Cycl.*, and *Antiq. of Hind. Med.* p. 84).

Cassia bark, also *Cassia lignea*, is imported from China, and from the Malabar coast of India, as was shown at length by Dr Royle in the first edition of this work. Cassia buds, which are aromatic, and have some resemblance to cloves, are exported from China, and yielded by the same plant.

Cassia resembles cinnamon. It is distinguished by its larger size, and the greater simplicity of the quills, which are usually single, seldom more than double, and from ¼ to ½ or even 1 inch in diameter. It is thicker, rougher, more dense, breaks with a shorter fracture, and is of a darker red colour than cinnamon, and its powder is of a reddish-brown tint. Its taste is more pungent and stronger, but not so sweet and grateful as that of the *true* cinnamon, and its odour is less agreeable. That from China is now always stripped of its epidermis.

That cassia cannot consist merely of inferior kinds of Ceylon cinnamon, as has been supposed by some, is sufficiently proved by the fact that the latter has, until recently, paid an export duty of 3s. a pound, whereas cassia, even in England, is barely worth 1s. a pound.

Some true cinnamon is certainly exported from the Malabar coast of India. Dr Wight states that he has found among the specimens furnished to him from thence the true cinnamon tree (*C. Zeylanicum*). He considers that all sorts of cinnamon-like plants, yielding bark of a quality unfit to bear the designation of cinnamon, are passed off as cassia. Mr Huxham, of Quilon, also states, that the only difference between Malabar cassia and Malabar cinnamon is, that the former is coarser and thicker than the latter. Both are obtained from the same tree, the cassia being the bark of the larger parts of the tree, and the cinnamon being peeled from the younger shoots and small branches.

A kind of cassia called *Cortex Malabathri*, *Mother cinnamon*, also *Wild cassia*, for some time almost unknown, has been lately imported in considerable quantities from Calcutta, Singapore, and Java. The pieces are thicker, flatter, and wider than those of common cassia, and yield a more mucilaginous decoction. Martiny states that it is produced by *Cinnamomum Tamala*, Nees v. E., a native of Bengal and Java.

Constituents.—These are identical with those of cinnamon, but cassia contains a larger quantity of starch and mucilage, the former is so abundant that its decoction becomes of an indigo-blue colour on the addition of tincture of iodine.

Oil of Cassia, like that of cinnamon, is almost wholly composed of cinnamyl hydride, and the only appreciable difference between the two is the sweeter, more delicate odour and flavour of oil of cinnamon.

Action and Uses.—Those of cinnamon.

SASSAFRAS OFFICINALE, *Nees.* The Sassafras Tree.

Sassafras was discovered by the Spaniards in Florida in 1528, but is common throughout the United States. The name is considered to be a corruption of Saxifrage (*De Theis*). "Sassafras nuts" or "Puchury beans" are the produce of some other Lauraceous plant, probably Nectandra.

Characters.—A small diœcious tree, but growing to a great height in favourable situations, with a trunk about a foot in diameter. *Bark* rough, furrowed, greyish, twigs smooth, and bright-green. *Leaves* alternate, petiolate, downy when young, membranous, varying much in form and size, oval and entire, with a lobe on one side only, or usually 3-lobed, all tapering into the petiole. *Flowers* slightly fragrant, pale yellowish-green, racemose, with deciduous subulate bracts. *Perianth* 6-parted. *Stamens* 9, the 3 inner with a thick stipitate gland on each side; *anthers* linear, 4-celled, introrse. *Female* flowers usually with fewer sterile stamens, the inner often all united together. *Drupe* oval, about the size of a large pea, of a deep blue colour, placed on the thickened apex of a reddish-coloured peduncle, surrounded by the cup formed by the remains of the perianth. Flowers in May in the north, but earlier in the south.—*Nees von E.* 131; *Woodv. Med. Bot.* plate 31.

Sassafras wood is light, porous, and fragile, whitish in the young, and reddish in the old tree, but feebly aromatic, and seldom employed in America. The bark is sometimes separated. The root is more efficacious. The bark of the root is in irregular pieces, flattish or curled, about 4 inches by 3, and $\frac{1}{6}$ of an inch thick. The inert corky layer is removed, and the inner surface is finely striated, and exhibits glittering points from the presence of minute crystals. It is highly aromatic, and has a short, soft fracture.

Sassafras pith is described by American writers as in slender, very light, and spongy pieces; mucilaginous in taste, with a slight flavour of the sassafras; forming a limpid mucilage with water, which is much used as a demulcent. The leaves are said by Dr Lindley to be used in Louisiana for thickening soup. They contain much mucilage.

1. **Sassafras Radix**, *P.B.* *Sassafras Root.*

The dried root of the plant described. From North America.

Characters and Constituents.—In branched pieces, sometimes eight inches in diameter at the crown; bark externally greyish-brown, internally rusty-brown, of an agreeable odour, and warm aromatic taste; wood light, porous, greyish-yellow, of feebler odour and taste than the bark. Also in chips.

The wood of the root yields from 1 to 2 per cent. of *volatile oil*, the bark of the root thrice as much. Oil of sassafras has the agreeable odour and taste of the root, and is the essential constituent. The sp. gr. is about 1·09. At a low temperature it deposits hard six-sided prisms of sassafras camphor, $C_{10}H_{10}O_2$, which retain the odour of the oil. According to Grimaux and Ruotte, oil of sassafras is chiefly ($\frac{9}{10}$ths) composed of *safrol*, a liquid having the composition of the oil, the sp. gr. of 1·114, and a fennel-like odour. With bromine it forms $C_{10}H_5Br_5O_2$, a crystalline body. They have also isolated *saffrene*, $C_{10}H_{16}$. It has the same odour as sasfrol, and a sp. gr. of 0·834. The root also contains tannic acid, and about 9 per cent. of a red colouring matter resembling cinchona-red, called *sassafrid* (Reinsch).

Action and Uses.—Sassafras is an aromatic stimulant and diaphoretic. It may be given freely in the form of infusion. The oil is much used in America to flavour drinks and tobacco, and as a perfume.

Pharmaceutical Use.—It is an ingredient of Decoctum sarsæ compositum.

NECTANDRA RODIÆI, *Schomb.* The Bebeeru or Greenheart Tree.

This is a lofty forest tree, with a smooth, erect, ash-grey stem, unbranched below. It is a native of British Guiana, growing in the rocky valleys of the Essequibo, Demerara, Cuyuni, Berbice, &c. The wood is olive-green and compact. It is much esteemed for shipbuilding.

Characters.—Leaves shining, oblong, acute, 5 or 6 inches long, with reflexed margins. *Inflorescence* cymose axillary. *Flowers* yellowish-white, glandular, with a jessamine odour. *Calyx* 6-parted, rotate. *Stamens* 12 in 4 series, the inner sterile. *Anthers* 4-celled, dehiscing by recurved valves. *Fruit* dry, obovate, slightly compressed. *Seed* solitary, about the size of a walnut, composed of two large pleno-convex cotyledons.—*Schomburgk, Hook. Jour. Bot.* 2d ser.

Nectandræ Cortex, *P.B.* *Beebeeru Bark.*

The bark of the tree above described, imported from British Guiana.

Characters and Constituents.—In large, flat, heavy pieces, from 1 to 2 feet long, 2 to 6 inches broad, and about ¼ of an inch thick; externally greyish-brown, internally dark cinnamon-brown. Taste strongly and persistently bitter, with considerable astringency.

According to Dr Maclagan the bark contains about 2·5 per cent. each of *berberia* ($C_{35}H_{40}N_2O_6$), *resin*, and *tannic acid;* also *nectandria* ($C_{20}H_{23}NO_4$), *two other alkaloids*, the nature of which have not yet been fully investigated, and *bibiric acid*, which is colourless, volatile, crystalline, and deliquescent. Berberia is the essential constituent. Watz regards it as identical with buxine, a substance found in bark and leaves of the common box (*Buxus sempervirens*), and Flückiger states that it is undistinguishable from Pelosine (see *Cissampelos Pereira*). Berberia is a colourless amorphous body, soluble in 1400 parts of boiling water, in 5 of absolute alcohol, and in 13 of æther, the solutions having an alkaline reaction. It is freely soluble in dilute acids, forming yellow uncrystallisable salts.

Pharmaceutical Use.—The preparation of Berberiæ sulphas.

BERBERIÆ SULPHAS, *P.B.* Sulphate of Berberia.

$C_{35}H_{20}NO_6,HOSO_3$ or $C_{35}H_{40}N_2O_6H_2SO_4$.

Preparation.—Acidulate 1 gallon of *water* with ½ fluid ounce of *sulphuric acid*, and with this exhaust 1 pound of coarsely powdered *bebeeru bark.* Concentrate to 1 pint, and when cold add gradually a little milk of lime until the fluid is nearly saturated, but still retains a distinct acid reaction. After two hours filter and wash the precipitate, and add to the filtrate a slight excess of *solution of ammonia.* Collect the precipitate, and wash it twice with 10 ounces of cold water. Then squeeze and dry the precipitate on a water bath. Pulverise the dry precipitate, and exhaust it with boiled rectified spirit. Add a little water, and recover the spirit by distillation. Add a slight excess of sulphuric acid to the remainder, and evaporate to dryness on a water bath. Pulverise the residue and treat it with 1 pint of cold water; filter, evaporate to the consistence of syrup, and spread it on plates, and dry at a heat not exceeding 140°.

Characters.—Dark brown translucent scales, forming a yellow powder, soluble in water and alcohol, and the solutions have a strong bitter taste. The aqueous solution gives a white precipitate with chloride of barium (sulphuric acid); and with caustic soda, a yellowish-white deposit (berberia), which is dissolved when the mixture is shaken with twice its bulk of æther. The separated æthereal solution leaves on evaporation a yellow translucent residue (berberia, which it has removed from the aqueous solution), entirely soluble in dilute acid. It is entirely destructible by heat. Water forms with it a clear brown solution.

Action and Uses.—Dr Rodie, after whom the tree is named, discovered the bitter principle of the bark, and used it with success in intermittent fever. Its febrifuge properties are far inferior to those of quinine, indeed the alkaloid can scarcely be regarded as superior in this respect to other vegetable bitters, and it would be well to regard the sulphate simply as an astringent tonic. It is well suited for the treatment of general debility and atonic conditions of the alimentary mucous membrane, for it rarely or never produces nausea and headache, which so often attend the use of quinine in delicate persons.

Dose.—1 to 3 grains as a tonic; 10 to 20 as a febrifuge. It may be given in solution with the mineral acids.

MYRISTICACEÆ, *R. Brown.* Nutmegs.

They are distinguished from Lauraceæ by their unisexual flowers; trifid, valvate calyx, the longitudinal dehiscence of the anthers; the arillate seed, ruminated albumen, and minute embryo.

MYRISTICA OFFICINALIS, *Linn.* The Nutmeg.

Myristica moschata, Thunb. *M. fragrans*, Hout.

A fine evergreen tree with dark shining leaves, somewhat resembling the pear, indigenous to the Molucca islands. It is cultivated in Sumatra, Malacca, Singapore, Southern India, Brazil, and the West Indies.

The nutmeg is the *Ionz-al-teeh* or fragrant nut of Avicenna.

At Bencoolen the tree generally fruits at the age of seven years, and continues productive for a long period, bearing all the year round.

Characters.—Leaves faintly aromatic, oblong, lanceolate, acuminate, glabrous, above dark green, paler beneath. *Male—Racemes* axilliary. *Flowers* diœcious or monœcious, small, yellowish, the pedicles of each supported by a minute bract. *Calyx* (1) urceolate, 3-toothed, thick, and fleshy, with short reddish pubescence. *Filaments* united into a thick, oblong, and obtuse column (1, 2). *Anthers* about 9, linear-oblong, attached round the upper part of the filamentous column (2), 2-celled, free at their base, opening longitudinally (3). *Female* (4)—*Peduncles* usually solitary axillary. *Perianth* as in the male. *Ovary* ovate; *style* short; *stigma* 2-lobed, persistent. *Drupe* pyriform or nearly spherical, about the size of a peach. *Pericarp* fleshy, splitting from the apex into two equal, thick, fleshy, astringent valves, and displaying the deep orange or scarlet-coloured branched *arillus* or *mace*, which embraces the nut so tightly as to impress it with superficial furrows. *Seed* (5) ovoid, attached by a large umbilicus to the bottom of the cell; its shell is hard, of a dark brownish-black colour, and glossy, its inner coat of a light-brown colour, thin, closely investing the seed, and dipping down into the substance of the nucleus, subdivides the albumin, and gives it a marbled (ruminated) appearance (6). The nucleus and its investment constitutes the "*nutmeg;*" it is composed of oily albumin, enclosing at its base a minute erect embryo (6), composed of two thick fan-shaped cotyledons with incised margins (7), and a 2-lobed plumule.—*Fl. Ind.* iii. p. 844; *Corom. Plant.* iii. t. 267; *Nees von E.* 133; *Steph. and Church,* 104.

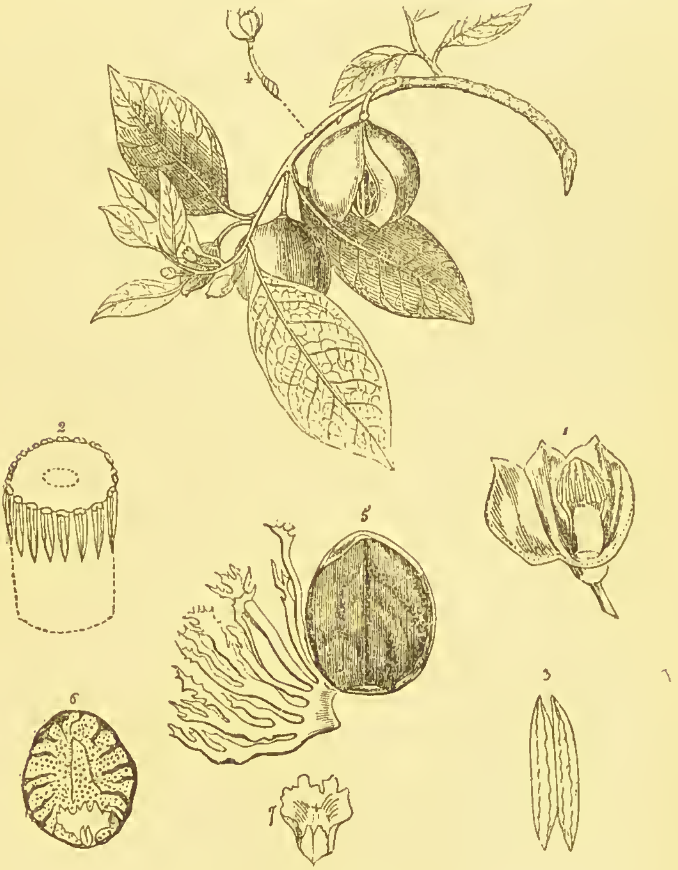

Fig. 73.—*Myristica officinalis.*

As soon as the pericarp splits, the fruit is collected, and the pericarp and mace separated. The seeds are then placed on frames in a drying-house until the kernel rattles in the shell; the latter is then broken and the nutmegs are picked out and sorted, and finally rubbed over with dry lime (Lumsdaine, *Pharm. Jour.* xi. p. 516). Liming in another form was employed by the Dutch to destroy the vitality of the seed, and it has passed into a custom. Penang nutmegs are not thus maltreated. The largest nutmegs fetch the highest price.

1. **Myristica**, *P.B.* *Nutmeg.*

The kernel of the seed of the plant above described, cultivated in the Banda islands of the Malayan Archipelago.

Characters and Constituents.—Oval or nearly round, about 1 inch long, marked externally with reticulated furrows, internally greyish-red, with dark brownish veins. It has a strong aromatic odour and taste, with some bitterness.

Nutmeg contains about 25 per cent. of *fat* (see Oleum myristicæ expressum), 2 to 3 per cent. of *volatile oil* (see Oleum myristicæ), starch, and albumin.

Action and Uses.—Carminative stimulant; in large doses narcotic, producing effects similar to those of camphor. It is employed as an adjunct to the following:—Pulvis catechu compositus (1 part in 10), P. cretæ aromaticus (1 part in 16), Spiritus armoraciæ compositus, Tinctura lavandulæ composita.

2. **Oleum Myristicæ expressum,** *P.B.* *Expressed Oil of Nutmeg.*

A concrete oil, obtained by means of expression and heat, from nutmegs. *Nutmeg butter*, erroneously called "*oil of mace.*"

Characters and Constituents.—Of an orange-red colour, firm consistence, and has the fragrant odour and aromatic taste of nutmeg. It is imported from Singapore in oblong blocks, about 10 inches long by 2½ square, enveloped in palm leaves. It is soluble in about 4 parts of warm alcohol. It contains 6 per cent. of the *volatile oil*, and several fatty acids in combination with glycerin, the most considerable of which is *myristicin*, $C_{48}H_{86}O_6$, which, by saponification, is resolved into *myristic acid*, $C_{14}H_{28}O_2$. Myristicin forms about half the weight of the expressed oil. It is soluble in æther and in benzol, and is deposited from them in a crystalline condition. It is insoluble in cold alcohol, which takes up a considerable portion of the other constituents. Myristicin is also found in spermaceti, and the oils of linseed and poppy.

Pharmaceutical Use.—A fragrant and anodyne constituent of Emplastrum calefaciens and E. picis.

3. **Oleum Myristicæ,** *P.B.* *Volatile Oil of Nutmeg.* $C_{10}H_{16}$.

Obtained in England by distilling powdered nutmeg with water.

Characters.—Colourless or straw yellow; sp. gr. about ·930. It boils at 329°, and has a powerful odour and taste of nutmeg. It contains an oxygenated oil (myristicol), which has the odour of nutmeg, and is isomeric with carvol and menthol.

Action and Uses.—Those of nutmeg, of which it is the essential constituent.

Pharmaceutical Uses.—In the preparation of Pilula aloes Socotrinæ, Spiritus ammoniæ aromaticus, and the following:—

4. **Spiritus Myristicæ,** *P.B.* *Spirit of Nutmeg.*

A mixture of 1 volume of the *volatile oil* and 49 volumes of *rectified spirit.*

Dose.—½ to 1 fluid drachm. It is a constituent of Mistura ferri composita.

Mace.—This, the large branched aril of the nutmeg, is of a crimson colour and fleshy consistence in the fresh state, and when dry, dull orange-yellow, and of a firm consistence. It is so full of fragrant oil as to exude it on the least pressure. It has the odour and taste of the nutmeg in a higher degree, containing as it does from 7 to 9 per cent. of volatile oil of nutmeg. The remaining constituents are —a thick aromatic *balsam,* consisting of a resin and semi-resinified essential oil (Flückiger); this corresponds to the fixed oil of nutmeg, and amounts to 25·5 per cent.; 1·4 of uncrystallisable sugar, and 1·8 of mucilage, the remainder being composed of albumin. According to Flückiger it is destitute both of fat and starch.

Action and Uses.—Those of nutmeg.

POLYGONACEÆ, *Juss.* Buckwheats.

Herbaceous plants, leaves simple with a revolute vernation, and ochreate stipules, ovary free, 1-celled, with a single erect ovule, and the embryo embedded in farinaceous albumin. They are remarkable for secreting a large quantity of oxalic acid, as in various species of Rumex and Rheum. The characters of the Order are well seen in the buckwheat (*Polygonum Fagopyrum*) and common garden rhubarb.

RHEUM PALMATUM, *Linn.* The Medicinal Rhubarb.

The name *rheum* is derived from the *ῥῆον* of Dioscorides; but his description does not well apply to modern rhubarb. This was, however, known to Paulus Ægineta, &c. The Arabs were acquainted with several kinds, as Indian, Khorassanee, Chinese (their *rewund sini*). The Persians give *reon* as the Greek synonym of their *rawund*, or rhubarb, and the plant they say is called *ribas.*

The different kinds of rhubarb are no doubt the produce of various species of *Rheum,* but the most approved kind, that imported from China, appears pretty conclusively to be the produce of the *R. palmatum,* with which Baillon's *R. officinale* specifically agrees. According to the latest observations, *R. palmatum* var. *tanguticum* is the source of the most genuine rhubarb imported from Siberia by way of Kiachta (*Regel's Gartenflora,* 1874).

Characters.—A perennial herbaceous plant, resembling the common garden rhubarb, but attaining a larger size than any other species. *Leaves* roundish, cordate at the base, 5 to 7 lobed, lobes irregularly and coarsely cut. *Inflorescence* paniculate, flowing stems 6 to 8 feet high. *Perianth* petaloid 6-parted. *Stamens* 9, inserted in pairs into the base of the 3 outer segments, and singly into the 3 interior; *filaments* subulate; *anthers* versatile. *Ovary* triangular, 1-celled. *Ovule* single, basiliary, orthotropous. *Styles* 3, short, reflexed.

Stigmas 3, entire, subdiscoid, spreading. *Achenium* 3-cornered, broadly winged, supported by the withered perianth at the base. *Seed* erect, triangular. *Embryo* straight, antitropous, in the axis of farinaceous albumen. *Cotyledons* flat; *radicle* short, superior.

Habitat.—China, Chinese Tartary, Thibet.

The root of the plant is valued on account of its purgative action.

The greater part of the rhubarb of commerce grows in Chinese Tartary, on the mountains and plains surrounding Lake Kokonor, near Thibet (*Pallas and Rehman*), especially in the province of Gansun, and is gathered in autumn from plants six years old. When dug up it is cleansed, peeled, cut into pieces; these are bored through the centre, strung on a cord, and dried in the sun. It is brought to Sinin, where the Bucharian traders reside, and is from thence sent to the Russian frontier town of Kiachta, and to Pekin, Canton, and Macao. Great care is bestowed at the Russian factory in separating the good from the inferior pieces and from impurities.

1. **Rhei radix**, *P.B.* *Rhubarb Root.*

The dried root deprived of the bark, from one or more undetermined species of *Rheum*. From China, Chinese Tartary, and Thibet. Imported from Shanghai and Canton, and brought overland by way of Moscow.

Characters and Constituents.—In trapezoidal, roundish, cylindrical, or flattish pieces, usually bored with a hole, yellow externally, internally marbled with fine waving greyish and reddish lines, finely gritty when chewed; taste bitter, faintly astringent and aromatic; odour heavy, characteristic. Free from decay, not worm-eaten. Boracic acid does not turn the yellow exterior brown (absence of turmeric, with which the exterior is often dusted to give a fine colour to the root).

The soft cells of the root are laden with *starch*, and aggregations of well-crystallised *calic oxalate*, which confer hardness and density on the root. According to Quekett, they form 35 to 40 per cent. of the root. The yellow colour is due to *chrysophanic acid* ($C_{14}H_8O_4$), which occurs in the form of golden-yellow prisms or laminæ, tasteless; feebly soluble in water, but soluble in alcohol, æther, benzol, and in alkalies, with which it forms dark red solutions. Cautiously heated it may be volatilised in yellow fumes. This substance is not peculiar to rhubarb, being found notably in the yellow lichen *Parmelia parietina* and in "*Goa powder.*" Besides these constituents rhubarb contains three resins, which have been named *aporetin*, *phæoretin* ($C_{16}H_{16}O_7$), and *erytheoretin*; also *emodin*, $C_{40}H_{30}O_{13}$ (De la Rue and Miller), a body resembling chrysophanic acid, and forming bold orange-coloured prisms; *rheo-tannic acid* ($C_{26}H_{26}O_{14}$), an abundant constituent soluble in water and alcohol, and giving blackish-green precipitates with persalts of iron, and blue ones with the protosalts; and *rheumic acid* ($C_{20}H_{16}O_9$), in small proportion, derived from rheotannic acid. The root yields a variable quantity (from 13 to 42 per cent.) of ash, composed of potassic and calcic carbonates. Of all these constituents it is not known which is the essential purgative principle. As this is readily soluble in water, it must be assumed to reside in a bitter extract, which is associated with the substances just described.

Substitutes.—The roots of the following species of rhubarb are substituted for that above described,—*Rheum Rhaponticum*, a native of Siberia, and cultivated in England as **English Rhubarb** since the early part of the 16th century. This species is chiefly cultivated at Badicott, near Banbury. The root exactly resembles Chinese rhubarb, but it is softer, more friable and mucilaginous, and less bitter. This species and the following, *R. palmatum*, *R. Emodi*, Wad., *R. compactum*, L., and *R. undulatum*, L., are cultivated on the Continent, and furnish **French and German Rhubarb.** It resembles the English, but much of it is inferior in appearance to Banbury rhubarb.

The so-called East Indian rhubarb is an inferior kind of the Chinese root. It is probably the residue from which the finer roots have been selected. It is imperfectly trimmed, is often hard and knotty, and presents greenish, brown, or blackish stains. "*Turkey rhubarb* is a thing of the past. As the rhubarb of the Levant disappeared from trade, that of Russia took not only its place but likewise its name, until the term Turkey rhubarb came to be the accepted designation of the drug imported from Russia" (*Hanbury and Flückiger, Pharmacographia*, p. 445).

Adulterations.—The powdered rhubarb of the English market is rarely found unadulterated. It is diluted with flour and brightened with turmeric. A fine yellow colour at once indicates adulteration, for the powder derived from the best and brightest coloured China rhubarb is of a dingy or greyish-orange colour, and it has a full heavy odour of rhubarb. Turmeric is indicated by the test given above, but as the rhubarb contains starch this adulteration cannot be so easily detected. As with many other drugs, a genuine specimen of the powdered root should be kept as a standard of comparison.

Action and Uses.—Rhubarb, as may be seen above, contains a considerable proportion of astringent matter, and, as its cathartic power is not great, small doses, 5 to 8 grains, are tonic, astringent, and slightly stimulant, promoting the digestive function by giving tone to the blood-vessels, and at the same time increasing the amount of the alimentary secretions. In larger doses (15 to 50 grains) this is obvious by a laxative or purgative action, with a considerable increase of the alvine secretions. Rhubarb is absorbed into the blood, for the urinary and cutaneous secretions are heightened in colour by its use. The purgative action is mild, and it is apt to be followed by constipation. I have commonly observed that the fæces are pale for a day or two after the aperient action of rhubarb. This is probably due to the astringent action of the rheo-tannic acid on the liver. As a safe aperient, and in combination with magnesia or sulphate of potash, it is usefully employed in the disorders of children; and as a stomachic it is beneficial in dyspepsia. In diarrhœa, when there is a remnant of indigestible matter in the alimentary canal, rhubarb is an appropriate remedy, as its aperient action is attended by astringency, and is followed by constipation.

Dose.—5 to 60 grains.

Pharmaceutical Uses.—It is employed only in the following preparations:—

2. **Infusum Rhei,** *P.B.* *Infusion of Rhubarb.*

Prepared by infusing ¼ ounce of *rhubarb root*, in thin slices, in 10 fluid ounces of boiling *water* for an hour, and straining.

Dose.—1 to 2 fluid ounces as a tonic stomachic; 3 to 5 ounces as a laxative.

3. **Tinctura Rhei,** *P.B.* *Tincture of Rhubarb.*

Prepared by exhausting 2 ounces of coarsely powdered *rhubarb root*, ¼ ounce each of separated *cardamom seeds* and *coriander fruit*, both bruised, and *saffron*, with a pint of *proof spirit*, in the manner prescribed for tincture of aconite, and obtaining 1 pint of the tincture.

This is a warming stomachic tonic or aperient, useful in diahrrœa or dyspepsia with flatulent colic.

Dose.—1 to 2 fluid drachms as a stomachic; ½ to 1 ounce as an aperient.

4. **Vinum Rhei,** *P.B.* *Rhubarb Wine.*

Prepared by macerating 1½ ounce of coarsely powdered *rhubarb root* and 60 grains of *Canella alba bark* in coarse powder in 1 pint of *sherry* for seven days, with occasional shaking, then straining, pressing, filtering, and adding sufficient sherry to make 1 pint.

Dose.—1 to 2 fluid drachms as a cordial; ½ to 1½ ounce as an aperient.

5. **Syrupus Rhei,** *P.B.* *Syrup of Rhubarb.*

Preparation.—Exhaust 2 ounces each of coarsely powdered *rhubarb root* and coarsely powdered *coriander fruit* packed in a percolator, with a mixture of 8 fluid ounces of *rectified spirit* and 24 ounces of *water*, Evaporate the percolated fluid to 13 fluid ounces, and in this, after it has been filtered, dissolve 24 ounces of refined sugar with the aid of a gentle heat.

Dose.—1 to 4 fluid drachms as an aperient for children, or laxative for adults.

6. **Extractum Rhei,** *P.B.* *Extract of Rhubarb.*

Mix 10 fluid ounces of *rectified spirit* with 5 pints of *water*, and macerate 1 pound of sliced or bruised *rhubarb root* in the mixture for four days; then decant, press and set by, that the undissolved matter may subside; pour off the clear liquor, filter the remainder, mix the liquors, and evaporate by a water bath at a temperature not exceeding 160° to a proper consistence for forming pills.

Action. Uses.—This is a very astringent extract. In doses of 5 grains it is stomachic; 10 to 30 grains act as a cathartic.

7. **Pulvis Rhei compositus,** *P.B.* *Compound Rhubarb Powder.*

A sifted mixture of 2 ounces of powdered *rhubarb root*, 6 ounces of *light magnesia*, and 1 ounce of powdered *ginger*.

This is commonly known as "*Gregory's powder.*" It is an useful antacid and laxative, and is especially adapted for children, and those who from delicacy of the alimentary mucous membrane are unable to bear stronger aperients.

Dose.—15 to 20 grains for children; 60 to 100 grains for an adult.

8. **Pilula Rhei composita,** *P.B.* *Compound Rhubarb Pill.*

Preparation.—Mix 3 ounces of powdered *rhubarb*, 2¼ ounces of *Socotrine aloes* in powder, and 1½ ounce each of powdered *myrrh* and *hard soap* in powder, with 1½ fluid drachm of *oil of peppermint;* then add 4 ounces of *treacle*, and beat the whole into an uniform mass.

This is a very useful digestive and mild aperient pill.

Dose.—5 to 10 grains.

LABIATÆ, *Juss.* Labiates.

The Labiatæ are nearly allied to *Verbenaceæ* and *Boragineæ*, more remotely to *Scrophulariaceæ.* They are known by a square stem, opposite leaves, labiate flowers, and didynamous stamens. They abound in volatile oil, usually containing stearoptene, and often contain a little bitter and astringent principle.

LAVANDULA VERA, *Dec.* Common Lavender.

A native of barren hills in Europe, and extending to the north of Africa. Cultivated in gardens; extensively at Mitcham, in Surrey, and Hitchin, in Herts, where 50 acres are now under cultivation with lavender.

Characters.—A branched hoary *shrub*, about 4 feet high. *Leaves* oblong, linear or lanceolate, entire, when young revolute. *Spikes* interrupted. *Whorls* of 6 to 10 flowers. *Floral leaves* rhomboid ovate, acuminate, membranous, the uppermost shorter than the calyx. *Bracts* scarcely any. *Flowers* bluish-grey. *Calyx* tubular, nearly equal, shortly 5-toothed, ribbed. *Corolla*, upper lip 2, lower 3-lobed ; all the divisions nearly equal ; the throat somewhat dilated. *Stamens* declinate. *Anthers* reniform, 1-celled. *Ovary* and fruit as in the order.—*Woodv. Med. Bot.* (*L. spica*), plate 55.

Lavender flowers, or rather tops, and collected in July and August, as usually dried, are well known by their spike-like appearance, greyish *lavender* colour, grateful fragrant odour, and warm bitterish taste. The properties depend on the presence of volatile oil, which is most abundant and perfectly formed in the flowers. It is obtained by distilling these with water. According to Bell, the flowers when carefully separated from the flower stalks yield 1½ per cent. of volatile oil. The flower stalks yield a quantity of oil, which lacks the delicacy of flavour characteristic of that obtained from the flowers. The oil is usually distilled from both flowers and flower stalks, either quite fresh or partially dried.

1. **Oleum Lavandulæ,** *P.B.* *Oil of Lavender.*

The oil distilled in Britain from the flowers of the plant above described.

Characters.—Colourless or pale yellow, with the very grateful odour of lavender, and a hot bitter aromatic taste; sp. gr. 0·87 to 0·94; boils at 397°. It is a mixture of a fluid hydrocarbon, $C_{10}H_{16}$, and *stearoptene*, the common solid constituent of volatile oils, which separates at a low temperature. The stearoptene of oil of lavender is, according to Dumas, identical with common camphor. It is soluble in rectified spirit, and in two parts of proof spirit. Like several volatile oils, it absorbs oxygen on exposure, and becomes acid.

Adulteration.—This oil is apt to be mixed with the oil of French lavender, commonly called *Oil of Spike*, which is a powerful but less agreeable oil.

Action. Uses.—Stimulant and carminative, and usually given in one of the following forms.

Dose.—1 to 10 minims.

Pharmaceutical Uses.—A constituent of Linimentum camphoræ compositum, and the following:—

2. **Spiritus Lavandulæ**, *P.B.* *Spirit of Lavender.*

A mixture of 1 volume of the *volatile oil* and 49 volumes of *rectified spirit.*

Used as a carminative and antispasmodic in hysteria.

Dose.—½ to 1 fluid drachm.

3. **Tinctura Lavandulæ composita**, *P.B.* *Compound Tincture of Lavender.*

Preparation.—Macerate 150 grains each of bruised *cinnamon bark* and bruised *nutmeg*, and 300 grains of *red sandal-wood* in 2 pints of *rectified spirit* for seven days, with occasional agitation, then strain and press; dissolve 1½ fluid drachm of *oil of lavender*, and 10 minims of *oil of rosemary* in the strained tincture, filter, and add sufficient rectified spirit to make 2 pints.

Used as a carminative antispasmodic, and as a colouring ingredient in Liquor arsenicalis.

Dose.—½ to 2 fluid drachms.

LAVANDULA SPICA, Decand. *French Lavender.*

A plant regarded by Linneus as a variety of *L. vera*, and only distinguished by its rather broader leaves, is the source of French oil of lavender or *essence d'aspic*, known in English pharmacy as *Oleum lavandulæ spicæ*, or *oil of spike*. It agrees in composition with the English oil, but lacks its delicacy of fragrance.

ROSMARINUS OFFICINALIS, *Linn.* The Rosemary.

Rosemary was called *Libanotis coronaria*, which the Arabs translated *akleel-al-jibbul*, or the Mountain Crown. It is a native of the rocky hills of the south of Europe, Asia Minor, and Syria, and is commonly cultivated in our gardens.

Characters.—A very leafy *shrub*, 5–6 feet high. *Leaves* sessile, elongated, narrow, revolute, hoary beneath. *Flowers* few, in short axillary subsessile opposite racemes, forming altogether a kind of spike. *Floral leaves* shorter than the purplish *calyx*, which is 2-lipped, the upper entire, the lower bifid. *Corolla* of a greyish-blue or lavender colour, not ringed in the inside, somewhat inflated in the throat, upper lip emarginate, the lower trifid, with the middle lobe larger, concave, and hanging down. *Filaments* shortly toothed near the base; *anthers* linear, with two divaricating confluent cells. Upper lobe of style very short.—*Flora Græca*, t. 14; *Steph. and Church*, plate 24.

Rosemary tops should be collected when coming into flower. They have a powerful odour, a warm and bitter, slightly astringent taste. Their properties depend on *volatile oil, bitter extractive*, and *tannin.*

Action. Uses.—Stimulant and carminative. Supposed to be useful in preserving the hair. Much employed as an ingredient in some perfumes, as *Hungary Water* and *Eau de Cologne.* "The admired flavour of Narbonne honey is ascribed to the bees feeding on the flowers of this plant" (*Lindl.*)

1. **Oleum Rosmarini**, *P.B.* *Oil of Rosemary.* $C_{10}H_{16}$.

The oil distilled from the flowering tops, with water.

Characters.—Colourless, with the odour of rosemary, and a warm aromatic taste. A cwt. of the herb yields 4 or 5 ounces of the oil. Sp. gr. 0·88; boils at 365°. The imported oil is usually very impure.

Action. Uses.—Carminative and stimulant, chiefly applied externally, and used as a perfume.

Pharmaceutical Uses.—A constituent of Linimentum saponis, Tinctura lavandulæ composita, and of the following:—

2. **Spiritus Rosmarini**, *P.B.* *Spirit of Rosemary.*

A mixture of 1 volume of the *volatile oil* and 49 volumes of *rectified spirit.*

Action. Uses.—Employed to impart an agreeable odour to lotions, and as a cutaneous stimulant.

MENTHA, *Linn.* Mint.

Generic Characters.—*Calyx* nearly equal, 5-toothed. *Corolla* with the tube enclosed; limb nearly equal, 4-cleft, the upper segment broader. *Stamens* 4, equal; *anthers* with 2 parallel cells. *Stigmas* at the points of the bifid style. *Fruit* dry, smooth.

Several of the Mints, remarkable for their odour and taste, have long been used in medicine (*Μίνθα*, Ἡδυοσμὸς, and *Καλὰ μίνθα* of the Greeks, *nana* of the Arabs), and some as sweet herbs; but it is difficult to distinguish one species from another by the short descriptions given.

MENTHA VIRIDIS, *Linn.* Spearmint.

Characters.—*Root* creeping. *Stem* smooth, erect. *Leaves* sessile, lanceolate, acute, unequally serrated, glabrous, glandular below, those under the flowers bractlike; these and the calices hairy or smooth. *Spikes* linear-cylindrical; bracts subulate. *Whorls* approximated, or the lowest or all of them distant. *Corolla* glabrous. Marshy places in the milder regions of Europe, introduced into many parts of the world. Collected when about to flower.—*Eng. Bot.* plate 2424; *Woodv. Med. Bot.* plate 170.

This plant has an agreeable odour, and a pleasant aromatic taste, with some bitterness.

Action. Uses.—Stimulant and carminative. It is the kind used by cooks.

1. **Oleum Menthæ viridis,** *P.B. Oil of Spearmint.*

The oil distilled (with water) in Britain from the fresh flowering herb.

Characters.—Colourless or pale yellow, with the odour and taste of spearmint; sp. gr. 0·914, boiling point 320°. According to Gladstone, the fluid portion, or *elæopten*, is identical both in physical and chemical properties with oil of turpentine, and the characteristic odour resides in the oxydised portion of the oil or stearoptene which is isomeric with carvol, $C_{10}H_{14}O$; has a sp. gr. of 0·951, and boils at 437°.

Action and Uses.—A stimulant carminative used in the following preparation as an adjunct to saline aperients and other medicines.

2. **Aqua Menthæ viridis,** *P.B. Spearmint Water.*

Prepared by distilling a mixture of 1½ fluid drachm of the *volatile oil* and 1½ gallon of *water*, and collecting 1 gallon.

Dose.—1 to 2 fluid ounces, or "ad libitum."

MENTHA PIPERITA, *Linn.* Peppermint.

Peppermint is an indigenous plant growing in watery places. It is cultivated extensively at Hitchin, Market Deeping, and at Mitcham.

Characters.—*Root* creeping. *Stem* procumbent, ascending, smooth, or with a very few spreading hairs. *Leaves* stalked, ovate, lanceolate, acute, rounded at the base, smooth, serrated; floral leaves smaller, lanceolate. *Spikes* lax, the uppermost whorls collected into a short obtuse spike, the lower ones removed from each other. *Calyx* tubular, glabrous below, with lanceolate subulate teeth.—*Esenb. and Eberm.* 165; *Eng. Bot.* pl. 687; *Woodv. Med. Bot.* plate 169.

Peppermint is remarkable for its diffusive aromatic odour, and its warm but agreeable taste, producing at first a sensation of warmth, but afterwards one of cold. Its properties depend on a volatile oil, a bitter principle, and some tannin; these are taken up by spirit, and to some extent by water. It may be prescribed in the following forms, or as an infusion.

Action. Uses.—Stimulant and carminative. Much used in flatulent colic, &c., or where a diffusible stimulant is indicated; or a medium required to counteract nausea or griping; or to cover the taste of other medicines.

1. **Oleum Menthæ piperitæ,** *P.B. Oil of Peppermint.*

The oil distilled (with water) in Britain from the fresh flowering tops. These are cut in August, and allowed to dry on the ground before it is subjected to distillation. 1 ton of the herb yields about 5 or 6 pounds of oil, or about 0·25 per cent.

Characters.—Colourless or pale yellow, with the odour of peppermint; taste warm aromatic, succeeded by a sensation of coldness in the mouth; sp. gr. 0·84 to 0·92. Exposed to 24° it occasionally deposits hexagonal crystals of *menthol* or *peppermint camphor*, $C_{10}H_{18},H_2O$. It has the odour and taste of the oil, and boils at 410°.

Chinese oil of peppermint is crystallised menthol. English oil of peppermint has a purer fragrance than any other, and commands a much higher price. Its superiority is due to cultivation on a dry, well-drained soil, and freedom from weeds.

Action and Uses.—See above.

Pharmaceutical Uses.—An ingredient of Pilula rhei composita, and as the essential constituent of the following:—

2. **Aqua Menthæ piperitæ,** *P.B. Peppermint Water.*

Prepared as directed for Aqua menthæ viridis, using the same proportions of volatile oil and water, and obtaining the same quantity of distillate.

Uses.—An aromatic menstruum for Mistura ferri aromatica and similar compounds.

3. **Essentia Menthæ piperitæ,** *P.B. Essence of Peppermint.* 1 vol. in 5.

A mixture of 1 volume of *oil of peppermint* and 4 volumes of *rectified spirit.*

Dose.—10 to 20 minims.

4. **Spiritus Menthæ piperitæ,** *P.B. Spirit of Peppermint.* 1 vol. in 50.

A mixture of 1 volume of *oil of peppermint* and 49 volumes of *rectified spirit.*

Dose.—½ to 1 fluid drachm.

MENTHA PULEGIUM, *Linn.* Pennyroyal.

This is supposed to be the Γλήχων of the Greeks, and the Pulegium of Pliny. It was a favourite medicine with the Anglo-Saxons. Pulegium (from *pulex*), signifies *fleawort.*

Characters.—*Root* creeping. *Stem* much branched, prostrate, rooting. *Leaves* about half an inch long, stalked, ovate, or elliptical, crenate, upper ones smaller, all with pellucid dots, a little hairy. *Whorls* sessile, all remote, globose, many-flowered. *Calyx* hispid, tubular, bilabiate, villous in the inside of the throat. *Corolla* light purple.—Wet places in many parts of Europe. Collected when beginning to flower.—*Eng. Bot.* 1026; *Esenb. and Eberm.* 167; *Steph. and Church*, pl. 45.

The whole herb has a powerful fragrant odour, and warm, aromatic, as well as bitter taste. Its properties depend on volatile oil.

1. **Oleum Menthæ Pulegii,** *P.B. Oil of Pennyroyal.* $C_{10}H_{16}O$.

Obtained in the same manner as oil of peppermint.

Characters and Composition.—Colourless or pale yellow, of a fragrant, but peculiar minty odour and taste; sp. gr. ·92, boiling point about 365°.

Action. Uses.—Stimulant and carminative, in doses of 2 to 5 minims.

2. **Aqua Pulegii.** *Pennyroyal Water.*

Prepared as peppermint water.

Action. Uses.—Those of peppermint water. It is powerfully aromatic.

THYMUS VULGARIS, *Linn.* Garden Thyme.

This fragrant little plant resembles our wild thyme, and grows in similar localities in Southern Europe.

Characters.—Stem shrubby, 8 to 10 inches high. *Leaves* sessile, greyish, hoary, ovate lanceolate, revolute. *Flowers* in terminal heads, and occasionally with a few whorls.

As with all this genus, the aromatic properties reside in a volatile oil.

Oleum Thymi. *Oil of Thyme (Oil of Origanum).*

This oil is obtained in the south of France by distillation of the whole plant. It is of a reddish-brown colour, and strong aromatic minty odour, and sharp burning taste. It is rendered colourless by redistillation, and both the red and colourless oils are found in commerce. The late Mr Daniel Hanbury has pointed out that this oil is erroneously called in English commerce "Oil of Origanum," an oil which does not appear to have been an article of commerce at any time, and which is quite different from the oil of thyme. The latter consists of a fluid portion, separable into cymene, $C_{10}H_{14}$, and thymene, $C_{10}H_{16}$, and of a solid crystalline body called thymol, $C_{10}H_{14}O$, which has a very pungent taste, and the aroma of the crude oil.

Action and Uses.—Oil of thyme is employed externally as a stimulant and rubefacient in rheumatism and sprains.

ORIGANUM VULGARE, *Linn.* Common Marjoram.

The ὀρίγανος of the Greeks and *satar* of the Arabs is supposed to be this plant. It is indigenous, and extends to the Himalayas.

Characters.—Stem erect, 1–2 feet high. *Leaves* stalked, broad, ovate, obtuse. *Spikes* oblong, 4-sided, imbricated, with bracts, clustered in corymbose panicles. *Bracts* ovate, obtuse, coloured, longer than the calyx, which has 5 equal teeth, and is 10–13 nerved, throat hairy. *Corolla,* upper lip straight, nearly flat; lower spreading, 3-fid.—*Eng. Bot.* 1143; *Steph. and Church,* plate 131.

MARJORANA HORTENSIS, Mœnch., the *Sweet Marjoram* of the gardens, is a native of the south of Europe and Syria.

Wild marjoram has a strong but rather agreeable odour, and a bitter aromatic taste, which it retains in its dry state. Its properties depend chiefly on its *volatile oil.*

Action. Uses.—Stimulant and carminative; used as an infusion.

Melissa officinalis, *Linn.* Common Balm.

This plant is supposed to be the Μελισσόφυλλον of Dioscorides.

Stem branched, 1-2 feet high. *Leaves* ovate, acute, cordate at base, crenate. *Flowers* white, in axillary unilateral racemes. *Calyx* 13-nerved, subcampanulate, slightly ventricose in front, 2-lipped, upper lip flat, truncate, with 3 short broad teeth, lower with 2 lanceolate teeth. *Corolla*, upper lip concave, lower spreading, trifid, with apices of stamens connivent under the upper lip of the corolla. *Anther-cells* divergent.—South of Europe; cultivated in English gardens.—*Esenb.* and *Eberm.* pl. 180.

Balm has an agreeable odour, like that of the citron, and a mild aromatic taste, with a little astringency. Its properties depend, as in the other Labiatæ, on volatile oil, bitter principle, and tannin. It is not now officinal.

Action. Uses.—A mild stimulant. Much used on the Continent in the slighter nervous affections, generally in the form of infusion (4 drachms to 1 pint of water), or *Balm tea.*

Salvia officinalis, *Linn.* Garden Sage.

This plant has been employed in medicine from the times of the Greeks, and is no doubt as useful as other Labiatæ for many of the same purposes. It is pungent and aromatic, and its oil contains stearoptene, while the plant abounds also in a bitter principle.

Marrubium vulgare, *Linn.* Horehound.

This is, like balm and sage, an aromatic stimulant, and has a long established reputation for relieving cough. It is usually given in the form of syrup, prepared from the infusion, or of "candied horehound," made by evaporating the syrup.

Scrophulariaceæ, *Brown.* Figworts.

They are allied on one side to Labiatæ, on the other to Solanaceæ. From the former they are known by their 2-celled, many-seeded fruit, and the absence of aromatic properties; and from the latter by their irregular corolla and didynamous stamens.

DIGITALIS PURPUREA, *Linn.* **Foxglove.**

Fuchsius was the first to describe this plant, and to name it Digitalis, from the resemblance of its flowers to the finger of a glove. The term Foxglove is a corruption of *Foxes' glew*, or foxes' music, in allusion to an Anglo-Saxon musical instrument of bells on an arched support. It was admitted into the London Pharmacopœia of 1668 and 1721, rejected in that of 1745. Withering brought it into permanent notice in 1775.

Characters.—Biennial. Hoary-pubescent. In the first year a tuft of radical leaves is thrown up, from the midst of which rises, in the second year, a stem of 1–5 feet high, which is erect, leafy, and slightly arched. *Leaves* alternate, ovate-lanceolate, or oblong, crenate, and rugose; downy, especially on the under surface, tapering into winged footstalks. *Racemes* terminal, long, and lax, the pendulous flowers are attached on one side, and open from below in regular succession. *Flowers* purple, sometimes white, hairy and spotted within. *Calyx* 5-parted, segments ovate, or oblong, acute. *Corolla* declinate, much longer than the calyx, contracted at the base, campanulate and ventricose above, with an oblique limb; upper limb emarginate, lower 3-fid, with the middle lobe the largest, all short, obtuse. *Stamens* 4, didynamous, ascending; anthers smooth. *Stigma* bilamellate. *Capsule* ovate-acute, with a septicidal dehiscence. *Seeds* very small, of a pale brownish colour, and pitted. *Habitat.*—Pastures and exposed hill sides, as well as in plantations; begins to flower in June and July, and ripens its seed in August and September.—*Nees von E.* 154; *Woodv. Med. Bot.* pl. 24.

The leaves only are officinal. The roots, collected in the autumn or winter of their first year, are possessed of active properties; so also are the seeds. Dr Robert Christison observes that their bitterness, which probably measures their activity, is very intense both in February and September, and that their extract is highly energetic as a poison in the middle of April, before any appearance of the flowering stem. The proportion of solid matter in the leaves is larger in summer than in spring. Von Hees found the amount of dry leaf yielded by the fresh leaf in May to be 15·8 per cent.; in July, 17·4 per cent. Full-grown and perfect leaves should therefore be selected.

1. **Digitalis folia,** *P.B. Digitalis Leaf.*

The dried leaf of the plant described. Collected from wild indigenous plants, when about two-thirds of the flowers are expanded.

Characters and Constituents.—Ovate-lanceolate, shortly petiolate, rugose, downy, paler on the under surface, crenate.

The essential constituent of the plant is *digitalin*, a bitter, non-nitroginised neutral principle. Walz, Kosmann, and Homolle (see below), have separated it in an amorphous or imperfectly crystalline condition,—the latter, however, from the seeds. Nativelle's process consists in exhausting the leaves first with water and then with alcohol; sp. gr. ·930. The resinous matter is precipitated by adding the concentrated tincture to thrice its weight of water. This deposit is dried on blotting paper, and then boiled with twice its weight of alcohol; sp. gr. ·907. The digitalin is slowly deposited in crystals after the solution has cooled. They form colourless needle-shaped prisms. It corresponds in character to those given below. Delffs digitalin is not coloured by the mineral acids; it is a glucoside, and has the composition $C_{17}H_{30}O_7$.

Substitution.—The leaves of Comfrey (*Symphytum officinale*), Mullein (*Verbascum Thapsus*), and Ploughman's spikenard (*Inula Conyza*) have been met with, owing to the carelessness or dishonesty of the collectors; but a cursory examination will readily detect them. The leaves of *Verbascum nigrum* closely resemble those of digitalis, but they are smoother, and have shorter stalks, and the plant is neither very common nor very abundant.

Action and Uses.—Digitalis is sedative, even to narcotism, and irritant, large doses producing in the healthy subject giddiness, staggering, and syncope, with pallor of the surface, dilated pupils, and a small irregular pulse. These symptoms are commonly attended with persistent vomiting and copious cold perspiration.

severe abdominal pain, and in most cases purging and ptyalism. Fatal cases terminate by collapse, occasionally attended with unconsciousness, suppression of urine, muscular twitchings, or even convulsions. Recovering from a poisonous dose is attended for some days by a continuance of the cardiac irregularity which marked its previous effects, and a tendency to syncope on resuming the upright posture. The cardiac irregularity produced by the plant is so marked and constant a symptom, that it is generally assumed to cause death by inducing prolonged spasm of its propelling fibres.

The following will serve to briefly illustrate my own observations on the effects of digitalis* in the healthy human subject:—Half an ounce of the tincture caused, in a female adult, persistent nausea and vomiting, attended by alarming prostration and irregular action of the heart, lasting several hours. Two fluid drachms of the tincture, taken at intervals of a few days by another strong woman, uniformly produced, during complete quietude in the sitting posture, nausea with slight increase in the force of the pulse during the first two hours, following by a progressive diminution of the natural force and frequency (from 15 to 20 beats) of the pulse, and a feeling of lethargy; and then, on resuming the erect posture, a return of the nausea, ending in intermittent retching with occasional vomiting and faintness, outbreaks of perspiration and a weak irregular action of the heart, attended by fluttering and occasional palpitation in the cardiac region, effects which persisted for several hours. These effects very closely resemble those which I have attributed to derangement of the vagus nerves (see action of opium). Less powerful doses (2 fluid drachms of the succus, or 5 grains of the freshly powdered leaves), produced, with equal uniformity, slight nausea, a little dizziness, and a heavy feeling across the forehead for three or four hours, attended and usually followed by languor and mental depression, without any appreciable influence on the heart or pulse. I am inclined to conclude that, apart from its cerebral effects (which are probably due to disturbance of the cerebral circulation rather than to a direct impression on the sensorium), digitalis is a stimulant both of the sympathetic and of the vagus nerve; that its stimulant action on the former is comparatively feeble, when used in large doses, being soon effaced by the more powerful action on the vagus. This conclusion is borne out by observations of its effects in disease, for although digitalis will, in full doses, produce a weak and irregular action of the heart in the healthy condition, it will be found to give tone and regularity to a heart enfeebled by debility or embarrassed by valvular disease. There can be no doubt that digitalis is tolerated to a far greater extent in a state of debility than in one of vigorous health; and it is consistent with our knowledge of the bodily functions, and of the action of other medicines, to assume that the healthy function is embarrassed by a stimulus which is beneficial to it when in a state of depression. It appears, too, that the sympathetic nervous system, as compared with the vagus, appropriates to itself, so to speak, a larger share of the influence of digitalis in the latter condition than in the former.

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* The preparations used were a tincture and succus prepared for me by Mr Buckle of Gray's Inn Road. London, from carefully selected plants.

The direct result of the action of digitalis on the sympathetic is to increase the contractile force of the heart and diminish the calibre of the blood-vessels, and the only question that remains is whether this stimulant action on the involuntary muscular fibre is of a spasmodic character, tetanising the heart, and so arresting the vital functions. Strychnia, we know, exerts in proper doses a continuously tonic influence on the voluntary muscular system, which in larger doses passes into intermittent spasm, and it may be so with digitalis in respect of the involuntary muscle; indeed, the observations of Dr Dickinson (*Medico-Chirurg. Trans.* vol. xxxix.) show that digitalis directly induces this spasmodic action in the uterine muscular fibre, and that the spasm is forcible enough to cause pain. In the use of digitalis, we must therefore be guided by the fundamental fact that *it directly promotes contraction of the involuntary muscular fibre.* In this it agrees with ergot, but there is this essential difference between the two drugs, the influence of digitalis is chiefly directed to the thoracic viscera—notably the heart and the stomach, while that of ergot is chiefly expended on the abdominal and pelvic viscera, and notably the uterus. Digitalis is a valuable remedy in cardiac and arterial disease, acting as a *tonic* in debility of the muscular fibre, of which irregular or intermittent action of the heart is so often the indication; and as a *sedative* where there is undue action either from general nervous irritability, or in the palpitation attending debility, exophthalmic goïtre, valvular disease, or aneurism. Owing to its action on the uterine fibre, as pointed out by Dr Dickinson, it is useful in *hæmorrhage* from a lax condition of the viscus, or the presence of internal tumours. It is also extremely serviceable in hæmorrhage, whether active or passive, tranquillising, as it does, the action of the heart, and at the same time diminishing the calibre of the blood-vessels. For this reason it is also very beneficial in the early stage of *inflammation*, and particularly in congestion of the kidneys and lungs. In general febrile conditions it may be given to diminish the pulse and temperature. In congestion of the internal viscera and the dropsy often consequent thereupon, digitalis exhibits an action which is not witnessed in other conditions, that of *diuresis.* This action is no doubt due to the contraction of the dilated capillaries and smaller blood-vessels, whereby the force and rapidity of the circulation in the part are both increased. In certain dropsies of a sthenic character, where, after the effusion, the blood-vessels have, under the influence of irritation, somewhat recovered their tone, it has been observed that digitalis fails to increase the flow of urine, and the use of digitalis in dropsy must therefore be discriminative. Large doses of digitalis have been recommended in delirium tremens. The doses in some cases have been so large that it had been well to have had positive proof of the medicinal value of the drug employed. In the absence of such evidence, and from my observations of the potent effects of much smaller doses of the tincture, I am inclined to estimate it very low. The results of the treatment of delirium tremens by this drug in King's College Hospital, at the time when I was connected with this institution, were very far from encouraging confidence in this practice. Its use as a depressent in acute mania carries with the recommendations both of reason and experience. But in the absence of inflammation, conium is a far more suitable remedy in this condition.

Digitalis is supposed to accumulate in the system, and at intervals to exert a powerful depressent action on the heart. This mistaken notion is due to the fact that the effects of digitalis are very prolonged, and the accidents which have been attributed to accumulation have been really caused by a too frequent repetition of the dose. A full dose should not be given oftener than once in twenty-four hours, and when small doses are given continuously twice or thrice a day to a patient in the recumbent posture, the pulse should be carefully examined at intervals of a few days in the sitting or erect posture.

Dose.—Of the powdered leaves, $\frac{1}{2}$ to 2 grains.

Antidotes.—In the syncope induced by opium, I have shown that atropia ($\frac{1}{60}$ of a grain injected subcutaneously) is the appropriate remedy, and I infer, therefore, that its use would be equally effectual in poisoning by digitalis. Diffusible stimulants and friction, with warmth to the surface would be necessary adjuncts.

2. Digitalinum, *P.B.* *Digitalin.*

The process adopted by the Pharmacopœia for the isolation of the active principle of digitalis is that of Homolle. It is as follows :—

Preparation.—Digest 40 ounces of *digitalis leaf* in coarse powder with 1 gallon of *rectified spirit* for twenty-four hours, at a temperature of 120°, then put them into a percolator, and when the tincture has ceased to drop exhaust the leaf by the slow percolation of another gallon of rectified spirit. Distil off the greater part of the spirit, and evaporate the remainder over a water bath until the whole of the alcohol has been dissipated. Mix the residual extract with 5 ounces of *water*, to which $\frac{1}{2}$ ounce of *acetic acid* has been previously added, and digest the solution thus formed with $\frac{1}{4}$ ounce of purified *animal charcoal*, then filter and dilute the filtrate with water until it measures 1 pint. Add *solution of ammonia* nearly to neutralisation, and afterwards 160 grains of *tannic acid* dissolved in 3 ounces of water. Wash the precipitate formed with a little water; mix it with a small quantity of rectified spirit and $\frac{1}{4}$ ounce of *oxyde of lead*, and rub them together in a mortar. Place the mixture in a flask, and add to it 4 fluid ounces of rectified spirit; raise the temperature to 160°, and keep it at this heat for about an hour; then add $\frac{1}{4}$ ounce of purified *animal charcoal;* filter; from the filtrate carefully drive off the spirit by the heat of a water bath; and lastly, wash the residue repeatedly with pure *æther.*

In this process an alcoholic extract of the dried leaf is first formed. The digitalin is dissolved out of this by dilute acetic acid. After nearly neutralising the acid by ammonia, the digitalin is precipitated as tannate, the tannic acid is subsequently removed by lead, with which it forms an insoluble compound, from which the digitalin is extracted by hot spirit. Washing with æther is directed to free the digitalin from resin.

Characters and Tests.—In porous mammillated masses or scales, inodorous, intensely bitter; readily soluble in spirit, almost insoluble in water and in pure æther; it dissolves in acids, but does not form with them neutral compounds. Its solution in hydrochloric acid is of a faint yellow colour, but rapidly becomes green. It is precipitated by tannic acid. It leaves no residue when burned with free access of air. It powerfully irritates the nostrils, and is an active poison, producing the effects of the plant, and, according to Homolle, possessing 100 times the potency of the dried leaves.

Dose.—$\frac{1}{60}$th to $\frac{1}{30}$th of a grain. If made into pills it should previously be dissolved in spirit, and added in solution to the other ingredients, in order to ensure equal subdivision of the drug.

3. **Infusum Digitalis,** *P.B.* *Infusion of Digitalis.*

Infuse 30 grains of dried digitalis leaves in 10 fluid ounces of boiling water for an hour, and strain.

Dose.—2 to 4 fluid drachms. It may be given for days every four or six hours.

4. **Succus Digitalis.** *Digitalis Juice.*

I have used this preparation for the last six years, and prefer it to the tincture on account of its more pleasant taste and odour. It is of a rich reddish-brown colour, and when prepared (as directed for Succus conii) from wild plants it is about half the strength of the tincture. Varying, as it must do, on account of locality and season, I nevertheless believe it is a more reliable preparation than the tincture.

5. **Tinctura Digitalis,** *P.B.* *Tincture of Digitalis.*

Prepared by exhausting 2½ ounces of *digitalis leaves* in coarse powder with 1 pint of *proof spirit,* in the manner prescribed for Tinctura aconiti, and obtaining 1 pint of the tincture.

Dose.—10 to 30 minims.

SOLANACEÆ, *Juss.* The Potato Family.

This Order is very closely allied, on the one hand, to Scrophulariaceæ, and, on the other, to Convolvulaceæ. It is hardly distinguished from the former by a regular, often plicate corolla, and 5 stamens.

NICOTIANA TABACUM, *Linn.* Tobacco.

Tobacco was introduced from America about the middle of the 16th century, and is now extensively cultivated in most parts of the world.

Characters.—Stem erect, branched and viscid, from 2 to 6 feet high. *Leaves* sessile, oblong, lanceolate, the lower ones decurrent, very large, a little hairy, viscid. *Flowers* in terminal panicles. *Bracts* linear-acute. *Calyx* tubular, swelling, 5-cleft, hairy, glutinous. *Corolla* rose-coloured, funnel-shaped, throat inflated, ventricose, limb spreading, plicate, 5-cleft with acuminate segments. *Stamens* 5, declinate. *Ovary* ovate. *Style* long. *Stigma* emarginate. *Capsule* 2-celled, 2-valved, opening crosswise at top, valves finally bifid. *Seeds* numerous, small, kidney-shaped.—*Nees von E.* 194; *Steph. and Church,* pl. 37.

The odour of the fresh plant is heavy, the taste bitter and disagreeable, the leaves invariably turn cinnamon brown on drying. Tobacco exists in two forms,—*the dried leaf* and *the manufactured leaf.* The object of the manufacturer is to destroy, by a process of fermentation, albuminous, resinous, and gummy constituents, which give rise to unpleasant products in smoking; aromatic ferment-oils are also developed in the process. Sugar or liquorice are added to the fermented leaf to give it the required pliability and consistency.

1. **Tabaci folia,** *P.B.* *Leaf Tobacco.*

The dried leaves of Virginian tobacco, the plant above described. Cultivated in America, and not manufactured.

Characters and Constituents.—Large mottled-brown ovate or lanceolate acuminate leaves, bearing numerous short glandular hairs; having a peculiar heavy odour and nauseous bitter taste; yielding, when distilled with solution of potash, an alkaline fluid which has the odour of nicotia, and precipitates with perchloride of platinum and tincture of galls.

Virginian tobacco contains from 6 to 7 per cent. of *nicotia* ($C_{10}H_{14}N_2$), the active constituent of the plant. Nicotia (nicotylia, nicotine) is a colourless, volatile and inflammable oily liquid, of sp. gr. 1·048; boils at 480°, and has a powerful and very acrid odour of tobacco and a burning taste. It is very soluble in water and the fixed oils, and is miscible in all proportions with alcohol and æther. It is powerfully alkaline and basic, but most of its salts are deliquescent, and therefore crystallise with difficulty. The double chloride of nicotia and zinc, however, forms bold crystals, and the iodine compound ($C_{10}H_{14}N_2I_3$) separates from a concentrated solution in ruby-red crystals. Mercuric chloride, plumbic acetate, and tannic acid give white precipitates with a solution of nicotia; with the cupric salts it yields a blue solution, like that formed by ammonia.

Nicotia exists in the plant in combination with citric and malic acids, and may be easily separated by mixing a strong aqueous solution with one of potash, which liberates the alkaloid, and then shaking the mixture with æther, which dissolves out the nicotia and carries it to the surface. In order to purify it from resin and fatty matters, oxalic acid is added to the ætherial solution; the oxalate of nicotia being insoluble in æther separates as a dense syrupy layer. This is washed several times with æther, and the nicotia is then liberated by potash, removed by æther, and distilled, after the æther has been allowed to evaporate, in a current of hydrogen.

Tobacco leaves yield, on distillation with water, a concrete volatile oil called *nicotianin* or *tobacco camphor;* it is tasteless and crystalline; they are also remarkable for the large quantity (16 to 27 per cent.) of inorganic matter. The bases are chiefly potash and lime, which are combined with nitric, phosphoric, malic, and citric acids.

Action and Uses.—Nicotia is a most energetic poison, producing in doses of $\frac{1}{4}$ to $\frac{1}{2}$ a grain faintness, intense and persistent nausea, vomiting, and purging, with cold clammy sweat and complete muscular relaxation. Owing to the volatility of nicotia, the same effects are produced by smoking 40 grains of manufactured tobacco, if the individual be unaccustomed to its use. The use of tobacco is so common that we are apt to underrate its extremely poisonous nature. An infusion of 30 grains of tobacco has proved fatal (Copland). The expressed juice of the leaf, applied to the head of a boy aged eight for the cure of ringworm, caused death in $3\frac{1}{2}$ hours (Weston). Death is preceded by complete collapse and sometimes convulsions, and it appears to be due to paralysis of the respiratory movements. Smoking is said to have a tranquillising effect on the cerebral function, and where there is excess of bodily vigour and restlessness it no doubt has this effect, but it must be regarded as a consequence of the depression of motor activity rather than the result of a direct action on the cerebral hemispheres. By a general depression of the nervous function, tobacco no doubt diminishes the natural appetites and renders abstinence more tolerable. Such, at least, we may assume to be the effect of tobacco before the system has become thoroughly accustomed to its use; but how long and to what extent this effect persists is doubtful, for many men use half an ounce of tobacco every day without experiencing any of the effects which $\frac{1}{10}$th of that quantity invariably produce in a person unaccustomed to its use. It is to be observed, however, that depression of the respiratory function at once puts the habitual smoker on a level with the abstainer in respect of susceptibility to the action of nicotia.

The medicinal use of tobacco depends on its *antispasmodic* or *muscle-relaxing power*, and it has been employed on this account in spasmodic asthma and tetanus, and for the relief of strangulated hernia, and the reduction of dislocations; but its use in these last named conditions has been superseded by that of chloroform. In the form of enema it is given for the relief of spasmodic colic and spasmodic retention of the urine. Locally, as snuff, it is errhine, and it may often be advantageously employed in this form to arouse the respiratory functions (as in poisoning by opium and prussic acid), or to promote discharge from the nares for the relief of cerebral congestion or megrim.

Antidotes.—Diffusible stimulants, external warmth, and artificial respiration.

2. **Enema Tabaci,** *P.B.* *Tobacco Enema.*

Infuse 20 grains of *leaf tobacco* (see above) with 10 ounces of *water* in a covered vessel for half an hour, and strain.

It is used for the relief of strangulated hernia and spasmodic retention of fæces or urine. Not more than 2 fluid ounces should be given at once to a delicate woman, nor should we give the whole to a robust man without due consideration, unless indeed he is accustomed to the use of tobacco.

HYOSCYAMUS NIGER, *Linn.* Henbane.

This indigenous plant has been employed in medicine from the earliest times; is the *ὑοσκύαμος* of the Greeks, the *bunj* of the Arabs, and the *henbell* or *belene* of Anglo-Saxon writers. The seeds are known by the name of *Khorassani ujwain* in India.

Characters.—Biennial, but under favourable conditions annual. *Roots* spindle-shaped, those of biennial plants resembling small parsnep-roots. The plants in the first year throw up a tuft of radical leaves which are petiolated, woolly, and possess little of that clamminess and odour which are peculiar to the mature plant. *Flowering stem* from 1 to 3 feet high, seldom branched, hairy; hairs glandular and viscid. *Leaves* sessile, subamplexicaul, occasionally decurrent, lower ones sometimes stalked, oblong acute, coarsely and unequally cut or sinuate, apparently pinnatifid, clammy, and fœtid, of a pale dull-green colour, slightly pubescent with long glandular hairs, like those of the stem, upon the midrib. *Flowers* nearly sessile, axillary unilateral, erect, much shorter than the leaves. *Calyx* funnel-shaped, 5-lobed, villous. *Corolla* funnel-shaped, limb spreading, 5-lobed, not quite equal, of a dull straw-colour, marked with dark purple veins. *Stamens* 5, declinate; filaments pubescent. *Ovary* ovoid, shining, 2-celled, with numerous ovules attached to the placentæ. *Style* filiform. *Stigma* capitate. *Capsule* opening transversely by a convex lid, 2-celled, many-seeded. *Seeds* small, roundish, finely dotted, of a light grey colour. *Habitat,* waste grounds throughout Europe and in Persia.—*Nees von E.* 192; *Steph. and Church,* pl. 9.

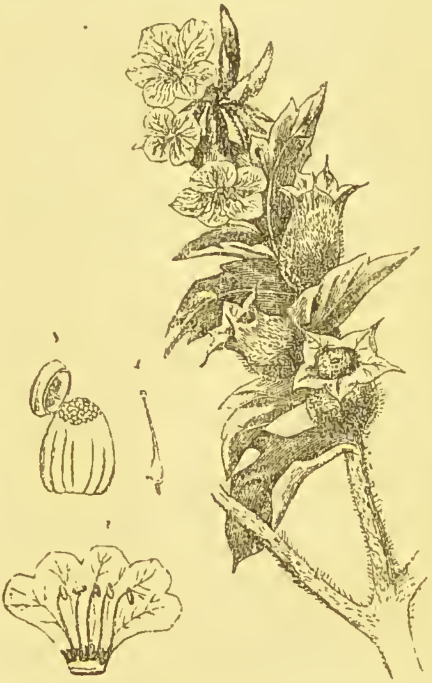

Fig. 74.—*Hyoscyamus niger.* 1. Pistil; 2 Corolla laid open; 3. Capsule dehiscent.

There are two varieties of henbane, the annual and the biennial kind. The latter, being most esteemed, is cultivated by Mr Ransom at Hitchin, where about four acres are set apart for it. The yield is from 1 to 5 tons of leaves per acre annually. The leaves of the first year are gathered in August to be sold as *Folia hyoscyami.* Those gathered in July of the second year are more active, and are used to make the extract. From 4 to 7½ lb. of this are obtained from 1 cwt.

of the plant. (*P. J.* 1860). The Pharmacopœia directs that the biennial plant should alone be employed, and that the leaves should be collected when the plant is in flower. But annual plants, when properly grown, are not devoid of active properties. Dr Royle cultivated henbane largely in the botanic garden at Saharunpore, where, from the nature of the climate, the whole process of cultivation, including the ripening of the seed, was completed between the months of October and March. The extract made from these plants was highly approved of by several medical officers, and pronounced by Mr Twining, after trial in the General Hospital at Calcutta, to be of "most excellent quality" (*Himal. Bot.* p. 281). But the secretions of plants growing in a colder and moister climate, or in seasons having these characteristics, may not come to as great perfection in the first year. Dr Christison states, "that inferiority of cultivated plants, if it exists at all, seems not appreciable in practice;" and, with respect to the period at which the leaves acquire their activity, he says, "I have found them sufficiently active even in the spring, before the appearance of the flowering stem."

Hyoscyami folia, *P.B.* *Henbane Leaves.*

The fresh leaves, with the branches to which they are attached, of the plant above described; also the leaves separated from the branches and carefully dried; gathered from wild or cultivated British biennial plants when about two-thirds of the flowers are expanded.

Characters and Constituents.—Leaves sinuated, clammy and hairy. The fresh herb has a strong unpleasant odour (like the rankest odour of the sudoriparous glands of the axilla), and a slightly acrid taste, which disappears on drying. The fresh juice dropped into the eye dilates the pupil.

The essential constituent of the plant is *hyoscyamia* ($C_{15}H_{23}NO_3$) (Höhn and Reichardt), an oily liquid, which concretes after a time into warty crystals. It has a heavy tobacco-like odour, and a slightly acrid, bitter, tobacco-like taste. It is soluble in water, alcohol, æther, chloroform, and benzol. It is slowly decomposed by caustic alkalies in the cold, and when boiled with baryta water it is resolved into a volatile alkaloid called *hyoscina* ($C_6H_{13}N$), and *hyoscinic acid* ($C_9H_{10}O_3$) a crystallisable substance having an odour resembling impure benzoic acid.

The following is the process which I have adopted for the separation of the hyoscyamia. Macerate the freshly ground seeds for eight days in a percolator with 1 pint of water, containing 1 per cent. of sulphuric acid, then percolate, and allow warm (100°) water to pass until the fluid has only a very faint acid reaction, and a feeble dilating power on the pupil. About 6 pints of fluid are thus obtained. Spread this in shallow layers on a number of flat dishes, and evaporate spontaneously in a dry warm room to about 8 ounces, strain from deposited crystalline matter (chiefly sulphate of potash), neutralise with carbonate of baryta, and wash with successive portions of a mixture of æther (9 vols.) and alcohol (1 vol.) until nothing more is removed. Recover the æther by distillation, and allow the alcoholic solution of hyoscyamia to evaporate spontaneously to dryness. Digest the residue in water, neutralise with sulphuric acid, and filter from resinous matter. Let the aqueous solution of sulphate of hyoscyamia evaporate spontaneously in a current of dry air, and dry over a dish of sulphuric acid. From this the alkaloid may be removed by solution of the sulphate in water, neutralisation with carbonate of soda, and evaporation by æther. But the sulphate as above prepared is a suitable form for use. It is a bright sherry-brown, gummy, semi-crystallised mass, retaining the odour and taste of the alkaloid. A solution carefully evaporated deposits a radiated mass of soft deliquescent prisms. The aqueous solution of this salt is very permanent; I have kept it unimpaired for seven years. One pound of the acid yields about 20 grains of the salt, of which 1 part in 100·000 of water dilates the human pupil from $\frac{1}{8}$th to $\frac{1}{6}$th, and maintains it so for five or six hours. $\frac{1}{8}$th of a grain given subcutaneously produced effects equal to 3 fluid ounces of the succus, or 2 fluid ounces of the tincture. The following observations on the action of the Hyoscyamus were made with this salt, and corroborated by the effects of the tincture given by the mouth (see *Old Vegetable Neurotics*, p. 322, *et seq.*)

Action and uses.—Henbane, like belladonna, produces dilatation of the pupil, somnolency, a parched condition of the tongue and mouth, and in sufficient doses delirium. The general action of henbane on the secretions and nervous system agrees in all respects with that of belladonna, and the results of its action are the same, but the influence of henbane on the cerebrum and motor centres is somewhat greater, while its stimulant action on the sympathetic is less. Both drugs directly stimulate the heart, but after moderate doses the action of henbane results in a sedative effect. Small doses of henbane are sedative and tonic to the heart; large doses excite it, and excessive doses depress it almost as readily as those of belladonna. Both drugs produce relaxation of the voluntary muscles and of the occluding fibres of the intestines and bladder. The following are the effects of sulphate of hyoscyamia given subcutaneously in increasing doses: $\frac{1}{48}$th of a grain is followed by slight somnolency, dryness of the mouth, and dilatation of the pupil. At first there is a little increase in the force and volume of the pulse, but this is soon followed by a progressive diminution in its frequency up to the end of the second or third hour, when the diminution amounts to about twenty-five beats. A moderate dose, the $\frac{1}{30}$th to the $\frac{1}{24}$th of a grain, causes the same cardiac effects with acceleration of its action during the first thirty or forty minutes, excessive giddiness, more decided somnolency, a parched condition of the tongue, mouth and fauces, and free dilatation of the pupil, these symptoms lasting for about two hours, and then rather suddenly declining. The $\frac{1}{16}$th to the $\frac{1}{12}$th of a grain is followed by the same effects in greater degree and more prolonged, accompanied by either wakeful, quiet, and usually pleasing delirium, with illusions of sight; or with such excessive somnolency that the patient cannot keep the eyelids raised for a few seconds, and when aroused lapses again into a dreamy sleep, broken by occasional mutterings and slight jerkings of the limbs. In either case the power of maintaining the erect posture will be lost, and at best the patient reels like a drunken man.

Hyoscyamia passes unchanged and undiminished through the blood, and is wholly eliminated by the kidneys, producing diuresis. I have detected its presence in the urine eighteen minutes after the subcutaneous injection of the $\frac{1}{48}$ of a grain of the sulphate. It produces temporary palsy of the muscular fibres of the bladder, causing retention, or at least dribbling of the urine on endeavouring to void the secretion, for some hours after the dose. From the foregoing account of its action, it is easy to deduce the remedial uses of henbane. 1. As a general sedative to the heart it claims our first consideration; and in emotional disturbances of the organ, the subcutaneous use of the $\frac{1}{48}$ of a grain of sulphate of hyoscyamia exercises a speedy and beneficial influence. In cardiac and pulmonary asthma it is a valuable remedy. In excited cardiac action from valvular disease, and in the angina which sometimes attends this condition, henbane often gives great and speedy relief. 2. As an anodyne I have used the alkaloid subcutaneously very successfully in sciatica and visceral neuralgia. In renal colic it is especially valuable, for the drug has in this condition both a general and a local action, the whole of the hyoscyamia passing over the irritated surface. In nephritis it is a topical remedy, and is most beneficial in allaying inflammatory irritation of the organ. 3. In spasmodic affections of the uterus, the bladder, the urethra, and erectile tissue (as in chordee), henbane is most beneficial. Spasmodic enuresis rapidly disappears under its use. By relaxing the cervical canal, it gives great relief in spasmodic dysmenorrhœa. 4. In hypochondriasis and emotional epilepsy I have found it serviceable in full doses (from ½ to 1½ ounce of the juice, or ½ to 1 ounce of the tincture). In convulsive and cerebral diseases generally, the use of henbane is contra-indicated.

Feeble old persons are remarkably susceptible of its action, and are often unpleasantly affected by ordinary doses.

It may be advantageously combined with opium, which intensifies and prolongs its action; the henbane, on the other hand, increases the anodyne effect of the opium, and counteracts its tendency to cause sickness and subsequent constipation.

Incompatibilities.—The caustic alkalies which decompose the hyoscyamia at temperatures below 100°, however, the action is slow, and is only observed after the alkali has been 24 hours or more in contact, so that a dose of caustic alkali may be taken with one of henbane without impairing the action of the latter.

2. **Succus Hyoscyami**, *P.B.* *Henbane Juice.*

Preparation.—Bruise the fresh leaves and young branches of the plant in a stone mortar, press out the juice, and to every three measures of it add one of spirit. Set aside for seven days, and filter. Keep it in a cool place.

Three fluid ounces are equivalent to 2 ounces of the tincture, or $\frac{1}{8}$th of a grain of sulphate of hyoscyamia given subcutaneously.

Dose.—As a hypnotic or antispasmodic $\frac{1}{2}$ a fluid ounce; as a renal or vesical anodyne and antispasmodic, 1 fluid drachm thrice a day; for old people, $\frac{1}{2}$ a drachm.

3. **Tinctura Hyoscyami**, *P.B.* *Tincture of Henbane.*

Prepared by exhausting $2\frac{1}{2}$ ounces of the leaves in coarse powder with a pint of proof spirit in the manner directed for tincture of aconite, and obtaining 1 pint of the tincture.

Now that a succus is provided, this preparation should be omitted; for, like all those obtained from dried leaves, it is liable to great variation, and from the presence of a large quantity of nauseous oleo-resin, this tincture is particularly disgusting. The succus is not quite so strong as the tincture prepared from the recently and carefully dried leaf, but it is to be preferred in every other respect. Two fluid ounces of tincture are equivalent in their action to 3 fluid ounces of the succus, and to $\frac{1}{8}$ of a grain of sulphate of hyoscyamia given subcutaneously.

Dose.—$\frac{1}{2}$ to 2 or 4 fluid drachms; the latter to be taken as a single occasional dose, as an antispasmodic, anodyne, or hypnotic, where opium is objectionable.

4. **Extractum Hyoscyami**, *P.B.* *Extract of Henbane.*

Preparation.—Bruise the fresh leaves and young branches of the plant in a stone mortar, and press out the juice; heat it gradually to 130°, and separate the green colouring matter by a calico filter. Heat the strained liquor to 200° to coagulate the albumin, and again filter. Evaporate the filtrate by a water-bath to the consistence of a thin syrup, then add to it the green colouring matter previously separated, and, stirring the whole assiduously, continue the evaporation at a temperature not exceeding 140°, until the extract is of a suitable consistence for forming pills.

In this process the albumin is removed in order to secure the better keeping of the extract, and the chlorophyll is returned in order to give it a good colour and proper consistence.

Carefully prepared extract is a very efficient preparation of henbane, and it is a valuable adjunct to cathartics, such as colocynth, podophyllin, as by allaying the spasm which often attends the condition for which these were prescribed, it facilitates their action, and at the same time prevents griping.

Dose.—5 to 10 grains. The last named dose is too large for aged persons, debilitated by disease.

Pharmaceutical Uses.—An ingredient (1 part in 3) of Pilula colocynthidis et hyoscyami.

OTHER SPECIES OF HYOSCYAMUS.—In the south of Europe *H. albus*, Linn., takes the place of our indigenous species. *H. insanus*, Stocks, a native of Beluchistan, and possessed of very powerful properties, is used medicinally and for smoking in India.

ATROPA BELLADONNA, *Linn.* Belladonna. Deadly Nightshade.

This plant has been supposed to be the Mandragora of Theophrastus, and the *Strychnos manicos* of Dioscorides; but it has been distinctly known only since the time of Matthiolus, who calls it *Solanum majus*, and tells us that the Venetian ladies used water distilled from the plant as a cosmetic, and hence the plant acquired the name *Herba Bella donna.* It is generally distributed throughout Central and Southern Europe, and is indigenous to England, but it has nearly disappeared. It is cultivated for medicinal

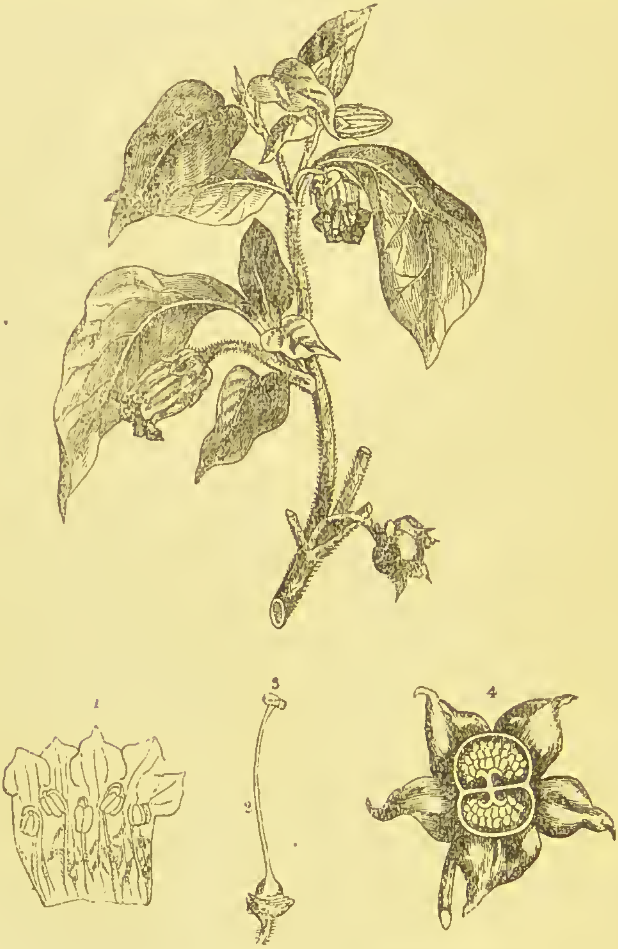

Fig. 75.—*Atropa Belladonna.* 1. coralla, opened; 2. pistil; 4. fruit.

use at Hitchin, where 4 acres are appropriated to this purpose. The yield of plant varies from 1 to 5 tons per acre.

Characters.—The plant has a greyish dingy hue, and, when bruised, a fœtid odour. *Root* perennial, branched, but fleshy, white internally. *Stems* annual, herbaceous, 3–5 feet high, branched, round, slightly downy or velvety, with a tinge of red. *Leaves* with short footstalks, lateral, often in pairs of unequal size, broadly ovate-acute, entire, smooth and soft, 4 or 5 inches in length, often with hairs on the under-surface. *Flowers* solitary, imperfectly axillary, stalked, about an inch in length, rather drooping. *Calyx* campanulate, 5-cleft. *Corolla* campanulate, an inch long, or twice the length of the calyx, greenish towards the base, but of a dark purple towards its 5-lobed equal border. *Stamens* 5, distant above. *Style* as long as the corolla. *Stigma* capitate. *Berry* seated in the enlarged calyx, globose, 2-celled, of a shining violet-black colour, about the size of a small cherry, with a longitudinal furow on each side, 2-celled, containing numerous reniform seeds in a mawkishly sweet pulp. Flowers in June or July ; berries are ripe in September.—*Eng. Bot.* pl. 552 ; *Nees von E.* 191 ; *Flor. Lond.* fasc. v. pl. 16.

The whole of the plant is replete with a deliriant principle, and both leaves and root are prescribed in the Pharmacopœia.

1. Belladonnæ folia, *P.B.* *Belladonna Leaves.*

The *fresh leaves*, with the branches to which they are attached; also the leaves, separated from the branches and *carefully dried;* gathered from wild or cultivated British plants when the fruit has begun to form.

Characters and Constituents.—Leaves alternate, 3 to 6 inches long, ovate, acute, entire, smooth, the uppermost in pairs and unequal. The expressed juice, or an infusion dropped into the eye, dilates the pupil.

Besides the ordinary constituents, the leaf contains *aspargin* ($C_4H_8N_2O_3H_2O$), a neutral substance remarkable for its perfect crystalline form (octohedra and rhombic prisms), and the ease with which it is resolved by the agency of either acids or alkalies into ammonia and aspartic acid, $HC_4H_6NO_4$; and the essential constituent *atropia* (see below). According to Lefort, the dried leaves of the flowering plant contain from 0·44 to 0·48 per cent. of the alkaloid; cultivation does not alter the proportion, but the leaves of a young plant yield a little less than those of the herb when in flower.

Pharmaceutical Uses.—The preparation of the Succus, Extract and Tincture

2. Belladonnæ radix, *P.B.* *Belladonna Root.*

The dried root of the plant described, cultivated in Britain or imported from Germany.

Characters and Constituents.—From 1 to 2 feet long, and from ½ to 2 inches thick, branched and wrinkled, brownish-white. An infusion dropped into the eye dilates the pupil.

The smaller and younger roots are to be preferred, for Lefort found that these, when about the thickness of the finger, yielded about 0·5 per cent. of atropia; whereas large roots, seven or eight years old, yielded only half this quantity. It appears, therefore, that the roots of young plants contain rather more atropia than the leaves. Besides atropia the root contains *belladonnin* (Hübschmann), an amorphous resinous-looking alkaloid, which emits, like atropia, a peculiar odour when heated; *atrosin* (Richter) a red colouring matter, and a fluorescent body.

Pharmaceutical Uses.—An ingredient of the Linimentum belladonnæ, and the source of the alkaloid.

3. **Atropia,** *P.B.* *Atropia.* $C_{34}H_{23}NO_6$ or $C_{17}H_{23}NO_3$.

An alkaloid, the essential constituent of Belladonna.

Preparation.—Macerate 2 pounds of *Belladonna root*, recently dried and in coarse powder, in 4 pints of *rectified spirit* for twenty-four hours, with frequent stirring. Transfer to a displacement apparatus, and exhaust with 6 pints more of *spirit* by slow percolation. Add 1 ounce of *slaked lime* to the tincture placed in a bottle, and shake occasionally several times. Filter, add *dilute sulphuric acid* in very feeble excess, and filter again. Distil off three-fourths of the spirit, add to the residue 10 fluid ounces of water, evaporate at a gentle heat, but as rapidly as possible, until the liquid is reduced to one-third of its volume and no longer smells of alcohol; then let it cool. Add very cautiously, with constant stirring, a solution of *carbonate of potash*, so as nearly to neutralise the acid, care, however, being taken that an excess is not used. Set to rest for six hours, then filter, and add *carbonate of potash* in such quantity that the liquid shall acquire a decided alkaline reaction. Place it in a bottle with 3 fluid ounces of *chloroform;* mix well by frequently repeated brisk agitation, and pour the mixed liquids into a funnel furnished with a glass stopcock. When the chloroform has subsided, draw it off by the stopcock, and distil it on a water bath from a retort connected with a condenser. Dissolve the residue in warm rectified spirit; digest the solution with a little *animal charcoal;* filter, evaporate, and cool until colourless crystals are obtained.

This is the process of Mein, slightly modified. The natural salt of atropia is extracted from the root by alcohol. The lime decomposes it, and sets free the atropia. The alkaloid is decomposed by heat, or by contact with water for any time, it is therefore at once converted into sulphate of atropia. The greater portion of the sulphuric acid is removed and separated as sulphate of potash, contact with an excess of the carbonate being avoided. An excess of the latter now liberates the atropia, which is at once dissolved out and separated by the chloroform. Mein obtained by his process 20 grains of the alkaloid from 12 ounces of the root.

Characters and Tests.—In colourless acicular crystals, sparingly soluble in water, more readily in alcohol and in æther. Its solution in water has an alkaline reaction, gives a citron-yellow precipitate with terchloride of gold, has a bitter taste, and powerfully dilates the pupil. It leaves no ash when burned with free access of air. It is an active poison. In contact a few hours with the caustic alkalies, with lime or baryta water, atropia is decomposed. Caustic ammonia effects the decomposition much more slowly than the other alkalies. From the observations of Ludwig and Pfeiffer it appears that it is resolved under the influence of these, as it is under that of strong hydrochloric acid, into *tropic acid* ($C_9H_{10}O_3$), and *tropina* ($C_8H_{15}NO$); these, plus a molecule of water, = atropia. Tropine is strongly alkaline, separates from æther in tabular crystals, and it is freely soluble in water and in alcohol.

Pharmaceutical Uses.—The preparation of Liquor atropiæ, Unguentum atropiæ, and the following:—

4. **Atropiæ Sulphas,** *P.B. Sulphate of Atropia.*

This is prepared by mixing 120 grains of atropia with 4 fluid drachms of water, gradually adding dilute sulphuric acid until the alkaloid is dissolved and the solution is neutral. It is then evaporated to dryness at a temperature not exceeding 100°.

Characters and Tests.—A colourless powder, soluble in water, and the solution is neutral to test paper. It leaves no ash when burned in the air.

This salt is more permanent in solution than atropia, and as it is more convenient both for external and internal use, the physiological action of Belladonna will be considered in this place.

Action.—Belladonna is the type of the mydriatic deliriants furnished by the Solanaceæ. The active principle atropia is rapidly eliminated by the kidneys (appearing in the urine a few minutes after its injection into any part of the subcutaneous tissue), undiminished and unchanged. As long as it remains in the blood it produces great commotion, in small doses, confined as I have shown, to increased action of the heart. In its primary and less obtrusive effects, it is in fact *a direct and powerful stimulant to the sympathetic nervous system*, under the influence of which the whole *circulation is increased in force and rapidity.* After larger doses there is usually a decided decrease in the volume of the smaller arteries. After still larger, there is only a moderate acceleration of the pulse and a positive decrease in the force of the pulsations. When the dose is excessive, the arteries will often be found dilated and their coats flaccid and collapsing under the slightest pressure: the skin is sometimes generally injected, presenting what has been termed a "scarlatinous rash." Usually it is a mere temporary blush; but in rare cases, and in persons of a delicate and irritable skin, the redness remains, and its disappearance is attended by slight roughness and desquamation. Since a moderate dose of belladonna diminishes the calibre of the smaller arteries, it has been assumed that the drug diminishes secretion, which is undoubtedly regulated by the sympathetic nerve. By excitation of the peripheral extremities of this nerve in the salivary and sudoriparous glands, it is supposed to close the gates, so to speak, against further secretion, and to act, for example, as a direct antagonist to sialagogues, which open the gates by paralysing these same peripheral nerves. Within certain limits and in a state of health, this explanation may hold good; but I believe the limit is reached by its constricting effects on the blood-vessels; for when these have become permanently dilated, either from enfeeblement of the sympathetic, as in phthisis, or from excessive irritation of the vaso-dilator nerves, then the influence of atropia in preventing secretion is very feeble. Thus I have often witnessed a recurrence of a violent paroxysm of facial neuralgia when the patient has been under the influence of a full dose of atropia, the mouth being completely dry and the tongue hard and parched; and I have seen the saliva run over this dry membrane and overflow the lower lip while the skin of the affected side has become exquisitely tender and the pupil sensibly contracted.

The more or less complete arrest of the secretion in the mouth during the action of a moderate dose of belladonna, is a local and exceptional effect, and one that does not extend to the glandular system generally. I have given belladonna extensively in fevers of all kinds, and have not remarked, as a general observation, that it has had any influence in retarding or diminishing the cutaneous secretion. When the mouth is parched by a sufficient dose, excessive sweating is sometimes kept in abeyance for a short time; but my own observations have not encouraged me to use it either in idiopathic ptyalism or in the profuse sweating of phthisis. Indeed, the use of belladonna in phthisis is generally contra-indicated; for those suffering from the disease are peculiarly susceptible of the cerebral effects of the drug, and the general distress under which they labour in the advanced stages of the disease is increased by its use.

On the liver and kidneys, belladonna acts as a cholagogue and diuretic. My observations lead me to the conclusion that medicinal doses at least are wholly eliminated by the kidneys. To these organs, and to the whole of the urinary tract, belladonna is therefore a topical remedy, acting both as a diuretic and an anodyne. Its effect in depressing the power of the centres of involuntary movement is well illustrated in its partially paralysing effects on the bladder. Retention of urine is a frequent result of a full medicinal dose of belladonna; and if a catheter be passed along the unresisting passage into the bladder, the urine falls out in a sluggish stream, accelerated apparently by no other force but its own gravity. The constrictor fibres of the intestines and of the ducts of glands are, in like manner, relaxed by belladonna, and of this we may take the dilatation of the pupil as the outward sign and exponent. The dilatation of the pupil under the influence of belladonna is active, and due to a stimulant effect on the sympathetic nerve. The function of the third nerve is, at the same time, scarcely or not at all depressed: this is proved by the normal contraction of the pupil, which may be witnessed during sleep, occurring when the patient is under the influence of belladonna.

The general effects of belladonna on the cerebro-spinal system resemble those of opium in being excitant, hypnotic, and to some extent anæsthesiant. The excitement, however, does not, as is the case with opium, produce cramp; and convulsion is a consequence, not a direct effect of the action of belladonna. So also the soporific effect is much less marked, and never amounts in man to narcotism, and the coma which closes life after a poisonous dose is like the convulsions which occasionally happen, a remote consequence, and not a direct effect, of the action of the drug.

Soporific effects follow moderate medicinal doses; whereas large doses produce insomnia and delirium, and poisonous doses prolong these effects until exhaustion and coma supervene.

The influence of belladonna is less marked in diminishing natural sensation than in relieving neuralgia, and its influence on morbid sensation is not merely palliative but remedial,—an effect which is partly attributable to a direct action on the nerve-tissue, and partly to the influence of the drug in removing hyperæmia, a frequent cause of pain. The prolonged use of belladonna appears to exhaust the control over the voluntary movements; for the slightest touch or a sudden noise will induce the most powerful tetanic spasms in animals who have been kept for many hours under the influence of the drug; and I have occasionally observed in patients who have taken belladonna for some time a remarkable precipitancy of action and general nervousness, with rapid breathing and cardiac action, excited by the slightest cause, and in one patient there were decided choreic symptoms.

The essential action of atropia appears to be hyperoxydation of the nerve-tissue. If the supply of oxygen were proportionally increased, the process would probably be sustained until nutrition failed; but the respiratory function is only rarely and exceptionally increased, the blood suffers deoxydation, the nervous system manifests general depression, and symptoms resembling those of poisoning by carbonic oxyde or carbonic acid supervene. The temperature falls, and the skin becomes cold and dusky; the respiratory movements become slower and shallower, the heart's action weaker, and torpor soon ends in coma. A fatal issue in man may be expected after the ingestion of 1 or 2 grains, or the subcutaneous injection of $\frac{1}{5}$ to 1 grain of atropia.

Medicinal Uses.—As a vasculo-cardiac stimulant, belladonna surpasses all other drugs. In all conditions therefore in which there is depression of sympathetic nerve force, such as *syncope* from asthenia or shock; in the *collapse* of cholera, aconite, colchicum, or digitalis poisoning; in failure of the heart's action from chloroform or other anæsthesiants, the subcutaneous use of atropia is the most appropriate and hopeful means of resuscitation. In the condition last mentioned, the distension of the right heart must be simultaneously relieved by venesection. In all these conditions atropia should be injected subcutaneously, and in doses of the sulphate not exceeding the $\frac{1}{50}$th of a grain, or the stimulant effect may be converted into a depressent one. Timely and judiciously used, belladonna is a valuable instrument in *acute inflammation*, relieving, as it does, in the most direct way capillary congestion and stasis. I have given it largely in *pneumonia* and *nephritis* with the best results. Theory has suggested, and experience has in my hands proved it to be the proper remedy in *acute nephritis;* for it has a topical influence in relieving both the irritation of active congestion and the congestion itself, by diminishing the calibre of the vessel and accelerating the flow of blood through them. Its true *diuretic* influence is manifested not so much in the increase of water as of urea. For the same reason, belladonna is a most valuable remedy in *scarlatina.* I have given it from the commencement of the disease, and as its action is directly antagonistic to the renal congestion which is so liable to supervene, so have I found it invaluable in preventing renal dropsy. The direct action of belladonna on the renal circulation declares this drug to be the appropriate means of arousing the renal function in *suppression of the urine.* Guided by the principles above enunciated, Dr T. T. Smith has found belladonna of service in *exophthalmic goitre* (*Lancet*, 1874), and I can corroborate his statements.

In *acute and chronic rheumatism* belladonna is useful, both in alleviating pain and in promoting the oxydising function. In *neuralgia*, arising from either functional disorder or inflammatory action, the subcutaneous use of atropia alone, or combined with opium, has proved in my experience most beneficial; while in *pain* or *spasm*, arising from irritation of the air tubes (as in asthma), gall ducts and ureters (from calculi), or bladder (as in spasmodic enuresis), belladonna is, like henbane, especially serviceable. By relieving spasm of the circular fibres and completely relaxing them, it *facilitates the passage of calculi* along the ducts, or *scybalous matter* through the lower bowel. Apart from its influence on the circular fibres, it has power to relieve constipation, where there is complete muscular torpor of the intestines, by stimulating the contraction of the longitudinal fibres of the bowel. If, however, the constipation be accompanied, as it so often is, with great flatulent distention and loss of power of the circular fibres, the use of belladonna is counter-indicated.

Treatment of poisoning by Belladonna.—The first endeavour must be to sustain the breathing. Opium may be used, not as an antidote but as a means of calming the nervous excitement if it be excessive, and we must remember that the patient is much safer in a state of insomnia and restlessness than he would be in a deep sleep. Narcotism is more to be dreaded in poisoning by belladonna than in poisoning by opium.

3. Liquor Atropiæ, *P.B.* *Solution of Atropia.*

A solution of 4 grains of atropia in 1 fluid drachm of rectified spirit, diluted with 7 fluid drachms of water.

The uncombined alkaloid in aqueous solution is not stable, and as an application to the eye it sometimes causes ophthalmia; this preparation ought, therefore, to be excluded from the Pharmacopœia, especially as the following is every way preferable.

4. **Liquor Atropiæ sulphatis**, *P.B.* *Solution of Sulphate of Atropia.*

A solution of 3 grains of the salt in 1 ounce of water.

1 fluid drachm contains $\frac{1}{2}$ grain, 10 minims the $\frac{1}{12}$th, and 1 minim the $\frac{1}{20}$th of a grain. It is unnecessarily strong for dilatation of the pupil, and inconveniently so for subcutaneous use. A solution half the strength would have been much more suitable for both purposes.

Dose.—For subcutaneous use as a cardiac stimulant, 2 minims; as an anodyne, 4 minims. Internally, 2 to 5 minims twice a day.

5. **Succus Belladonnæ**, *P.B.* *Belladonna Juice.*

Prepared in the manner and proportions prescribed for henbane juice (see p. 486).

Like all vegetable juices, the proportion of active principle to the quantity of water varies according to the succulency of the plant, and this is, of course, dependent on two conditions—the locality and the amount of rainfall in May, June, and July. When grown in an exposed situation, and in a moderately dry season, 30 minims of the succus taken by the mouth are equivalent in their effects to $\frac{1}{60}$ of a grain of sulphate of atropia given subcutaneously.

Dose.—10 to 20 minims twice a day.

6. **Tinctura Belladonnæ**, *P.B.* *Tincture of Belladonna.*

Prepared by exhausting 1 ounce of *belladonna leaves* in coarse powder with 1 pint of *proof spirit*, in the manner prescribed for tincture of aconite, and obtaining 1 pint of the tincture.

Dose.—5 to 20 minims.

7. **Extractum Belladonnæ**, *P.B.* *Extract of Belladonna.*

Prepared in the manner prescribed (p. 487) for extract of henbane.

Dose.—$\frac{1}{4}$ to 1 grain.

8. **Emplastrum Belladonnæ**, *P.B.* *Belladonna Plaster.*

Preparation.—Rub 3 ounces of *extract of belladonna* with 6 fluid ounces of *rectified spirit*, and when the insoluble matter has subsided decant the clear solution, remove the spirit by distillation or evaporation, and mix the alcoholic extract thus obtained with 3 ounces of *resin plaster* melted by the heat of a water bath, continuing the heat until with constant stirring the plaster has acquired a suitable consistence. The efficient portion of the extract is removed by the spirit; but this is a parsimonious method, and the result is a dirty application. A much more elegant and more efficacious preparation may be formed by adding 6 grains of sulphate of atropia dissolved in a little spirit to 3 ounces of pitch plaster melted over a water bath.

Use.—Anodyne, antispasmodic, and sedative in neuralgia, sciatica, and rheumatic pains generally, and in palpitation and gastralgia. In spreading the plaster the heat employed should never exceed 212°.

9. **Linimentum Belladonnæ**, *P.B. Belladonna Liniment.*

Preparation.—Moisten 20 ounces of *belladonna root* in coarse power with *rectified spirit* in a percolator, and macerate for three days, then adding *rectified spirit*, allow slow percolation into a receiver containing 1 ounce of *camphor* until the product measures 1 pint.

This is a potent anodyne and stimulant application, and is usually employed diluted with three or four parts of soap liniment.

10. **Unguentum Atropiæ**, *P.B. Ointment of Atropia.*

Prepared by dissolving 8 grains of *atropia* in $\frac{1}{2}$ a fluid drachm of *rectified spirit*, and then mixing it with 1 ounce of *prepared lard.*

Use.—An external application in neuralgia. It is too strong for application to the rectum or vagina, unless the quantity does not exceed 2 or 3 grains=about $\frac{1}{30}$ to $\frac{1}{20}$ of a grain of atropia. This quantity, mixed with a little simple ointment, may be applied per anum or per vaginam in spasmodic or neuralgic affections of these and contiguous parts.

11. **Unguentum Belladonnæ**, *P.B. Belladonna Ointment.*

Prepared by softening 80 grains of *extract of belladonna* with a few drops of *water*, and mixing it with 1 ounce of *prepared lard.*

This ought to be replaced by an "Unguentum atropiæ dilutum," made by mixing No. 10 with 9 parts of simple ointment.

DATURA STRAMONIUM, *Linn.* Thornapple.

Species of Datura (Sanskrit *dhatoora*) have long been employed medicinally by the Hindoos, and were thus made known to the Arabs, who curiously give Stramonia as a synonyme of Datura. It is their *jouzmasil*,—that is, *masil* or *methel*, which has long been referred to Datura. *D. Stramonium* occurs in the Himalayas (see *Himal. Bot.* p. 279), and is probably indigenous in the Hindoo Koosh, whence most likely it was taken to Constantinople, having been obtained by Gerard from that city, and by Fuchsius from Italy. It is found in waste places and on dung heaps in all parts of Europe and North America, and has probably been disseminated from Asia.

Characters.—An annual of vigorous growth, about 3-5 feet high, flowering in July. *Stem* much branched, dichotomous above, bushy, smooth. *Root* large, white, and fibrous. *Leaves* from the forks of the stem, large, unequal at the base, ovate, unequally sinuate-dentate, smooth, variously and acutely sinuated and toothed, simply veined, of a light dull-green colour. *Flowers* axillary, erect, white, sweet-scented, especially at night, about 3 inches long. *Calyx* oblong, tubular, ventricose, 5-angled, 5-toothed, dropping off and leaving a circular mark round the base of the ovary. *Corolla* funnel-shaped, regular, angular, plicate with mucronate lobes. *Stamens* 5. *Stigma* thick, obtuse, 2-lobed. *Ovary* 4-celled. *Capsule* as large as a walnut, dry, very prickly, 4-valved, with 2 partially bipartite cells, containing many brownish or black flattened reniform seeds.

Variety—T. Tatula differs only in colour, the stem, leaf, stalks, and nerves of the leaves being purplish, and the corolla violet.—*Nees von E.* pl. 193; *Woodv. Med. Bot.* pl. 124.

The whole plant has a rank odour, which may be detected at a distance, but it disappears in drying. All parts possess medicinal properties.

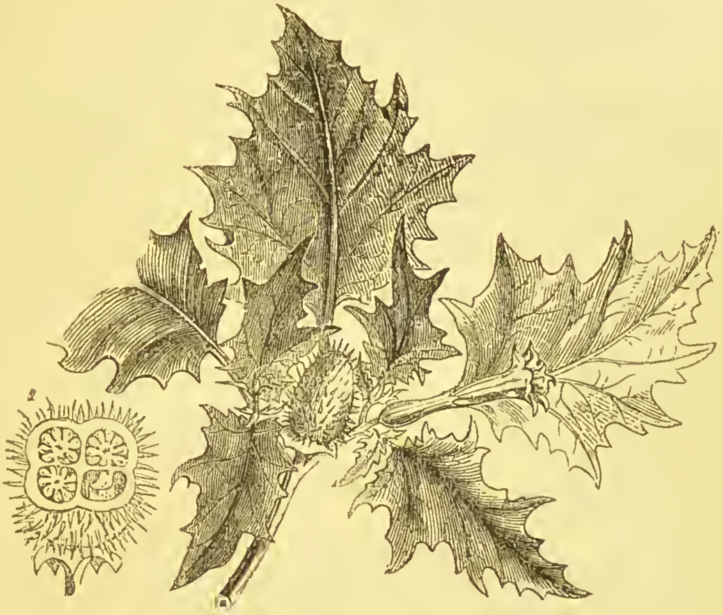

Fig. 76.—*Datura Stramonium.* 1. *Fruit* in section.

1. **Stramonii folia**, *P.B.* *Stramonium Leaves.*

The dried leaves of *D. Stramonium.* Collected from plants in flower; cultivated in Britain.

Characters and Constituents.—Large, ovate, sinuous, deeply cut; of a heavy odour, which is strongest while they are drying, and of a mawkish faintly bitter nauseous taste. The leaves, like those of tobacco, abound in nitrates, and yield a large quantity of ash (about 17 per cent.) They contain fixed oil, wax, resin, and about 0·02 to 0·03 per cent. of *daturia*, the active constituent; it is combined with malic acid. According to Von Planta, *daturia* is identical with atropia, and it possesses the same physical properties and physiological action.

Action and Uses.—Those of henbane leaves. The dried leaf rolled into cigars or cigarettes is smoked in asthma, in the spasmodic form of which it gives great relief. It is also serviceable in spasmodic affections of the larynx, whether dependent on functional disorder or organic disease.

2. **Stramonii semina**, *P.B.* *Stramonium Seeds.*

The ripe seeds of *D. Stramonium.*

Characters.—Dark grey, reniform, flat, and coarsely reticulated; $\frac{1}{6}$ of an inch long and about $\frac{1}{8}$ wide; feebly bitter and mawkish; when bruised they emit a disagreeable heavy odour. The testa yields a tincture exhibiting a green fluorescence. The seeds are composed of oily albumin, enclosing the curved embryo, and covered by the dark wrinkled testa. They yield about $\frac{1}{10}$ per cent. of *daturia*, 25 per cent. of fixed oil, and 3 per cent. of ash.

Action.—Closely resembles that of belladonna.

Pharmaceutical Uses.—The preparation of the two following articles:—

3. **Extractum Stramonii**, *P.B.* *Extract of Stramonium.*

Preparation.—Pack 1 pound of *stramonium seeds* in coarse powder in a percolator, and free it from its oil by passing 1 pint or a sufficiency of *æther* washed with ½ pint of *water*, slowly through it. Then exhaust the residue with proof spirit; distil off most of the spirit from the tincture, and evaporate the residue by a water bath until the extract has acquired a consistence suitable for forming pills.

Dose.—¼ to ½ a grain as an anodyne and antispasmodic; chiefly used in spasmodic asthma.

4. **Tinctura Stramonii**, *P.B.* *Tincture of Stramonium.*

Prepared by exhausting 2½ ounces of bruised *stramonium seeds* with 1 pint of *proof spirit* in the manner prescribed for Tinctura aconiti, and obtaining 1 pint of the tincture.

Dose.—10 to 30 minims.

DATURA ALBA, Nees, *White flowering stramonium*, and D. FASTUOSA, L., two plants which can hardly be regarded as specifically distinct, are common in India. They resemble *D. Stramonium* in habit, but the former is a larger plant, and its handsome white tubular flowers are five or six inches long; the spiny capsules are pendent, and the seeds are a little larger than those of *D. Stramonium*, light yellowish-brown, and the testa is not so regularly pitted and does not yield a fluorescent tincture.

The seeds and fresh leaves of the plant are prescribed in the *Pharmacopœia for India.* The properties of the plant are identical with those of *D. Stramonium*, than which it appears to be much more potent. It is often used in India with criminal intent.

CAPSICUM FASTIGIATUM, *Blume.* The Capsicum.

The several species of capsicum are natives of South America, whence they have been introduced into the Old World, and become universally diffused, from the fondness of Asiatics for warm condiments. The Hindoos cultivate the capsicum extensively, and call it *Red Pepper*, having no specific name for it. "Chilli, either simply or in composition, being the Mexican name for all the varieties and species of this genus" (*R. Brown*), indicates its American origin.

Characters.—A small branched *shrub*, 1–2 feet high, with quadrangular, fastigiate, rough branches. *Leaves* ovate or lanceolate, entire, ciliated. *Flowers* small, white, axillary, solitary, drooping. *Calyx* 5-cleft. *Corolla* rotate, equal. *Stamens* 5; filaments short. *Ovary* 2-celled. *Capsule* oblong, cylindrical, straight, when ripe deep red, very pungent. *Seeds* numerous, nearly white, flat, reniform.

Habitat.—Tropical America, Africa, and India.—*Wight, Icones Plant. Ind. Orient.* vol. iv. plate 1617.

1. Capsici fructus, *P.B.* *Capsicum Fruit.*

The dried ripe fruit of the plant above described, imported from Zanzibar, and distinguished in commerce as Guinea pepper, Pod pepper, Red pepper, and Chillies.

Characters and Constituents.—Pod membranaceous, orange-red, of an intensely acrid burning taste, from 5 to 8 lines long and 2 broad, straight, conical pointed, smooth, shining, but somewhat shrivelled.

The acrid principle, *capsicina*, is contained in a bright orange-red oily liquid obtained by æther from an alcoholic extract. It is when pure a volatile and crystalline alkaloid which forms crystallisable salts with the organic and inorganic acids. ½ a grain of the alkaloid, when diffused by heat through a large apartment, renders the air very irritating, and the same quantity dissolved in a pint of water, forms a solution, a teaspoonful of which could be hardly borne in the mouth. When heated with caustic potash, an odour resembling conia is developed, and when the mixture is distilled, an alkaloid having this odour passes over.

Action and Uses.—Capsicum, like the true peppers, is a violent stimulant to the nerves of common sensation and those of taste. In contact with the tongue or fauces, it causes a most intense pricking and burning sensation; applied to the conjunctiva, the most severe smarting; and if a concentrated tincture be painted on the more sentient parts of the surface, as the fingers or toes, it produces for hours a most intolerable burning, as if the part were roasting before a strong fire. These effects may be totally independent of vascular excitement. Owing to the strong and direct impression on the afferent nerves, capsicum is useful in evoking secretions from the alimentary canal, promoting the flow of saliva and gastric juice, and it is universally employed for this purpose as a condiment, especially and often to an injurious extent in hot climates. It may be given in atonic dyspepsia, and to arouse the paralysed absorbent function in poisoning by opium, after any unabsorbed portion has been removed from the stomach, and to promote the absorption of suitable remedies.

Dose.—½ to 2 grains of the powder (as Cayenne pepper) given in the form of pill, with bread crumbs or confection of roses.

2. Tinctura Capsici, *P.B.* *Tincture of Capsicum.*

Prepared by exhausting ¾ ounce of bruised *capsicum fruit* with 1 pint of *rectified spirit*, in the manner prescribed for tincture of aconite, and obtaining 1 pint of the tincture.

Uses.—Chiefly employed as a gargle (1 part of the tincture to 50 of the menstruum) in sore throat and laryngitis. It is chiefly useful in the acute state when there is pain from dryness of the inflamed membrane, the object being to excite secretion. In the relaxed form it is of no benefit. A strong tincture has been recommended as an application to chilblains, but my early personal experience of this treatment led me to conclude very decidedly that the remedy was worse than the disease.

Dose.—10 to 20 minims.

Capsicum annuum, L.—This herbaceous plant, sometimes cultivated in our greenhouses, is the source of a large proportion of the Pod pepper of commerce. The fruits are five times larger than those of *C. fastigiatum*, being between 2 and 3 inches long; they are conical, tapering from a wide base, and the extremity is often recurved.

SOLANUM DULCAMARA, *Linn.* Woody Nightshade or Bittersweet.

Dulcamara is supposed to have been employed by the ancients, but has been distinctly known only since the time of Tragus.

Characters.—Root woody. *Stem* shrubby, flexible, twining in hedges and over shrubs to the height of 12 or 15 feet. *Leaves* cordate-ovate, the upper ones more or less auriculate, halberd-shaped, all generally smooth, acute, and entire at the margin. *Racemes* spreading, cyme-like, opposite to the leaves, or terminal. *Flowers* drooping. *Bracts* minute. *Calyx* permanent, 5-parted. *Corolla* rotate, 5-parted, purple-coloured, with 2 green spots at the base of each segment. *Anthers* 5, yellow, erect, connivent, opening by 2 pores at the apex. *Berry* scarlet, ovoid, juicy, many-seeded. Indigenous in woods and hedges throughout Europe; found also in Asia and America.—*Nees von E.* pl. 188; *Woodv. Med. Bot.* pl. 33.

1. Dulcamara, *P.B. Dulcamara.*

The dried young branches of the plant above described, from indigenous plants which have shed their leaves.

Characters and Constituents.—Light, hollow, cylindrical, about the thickness of a goose quill, bitter, and subsequently sweetish.

According to Wittstein, the stem of the plant contains nearly $\frac{1}{10}$ per cent. of *dulcarmarine*, an amorphous alkaloid of a bitter-sweet taste. Schoonbroodt separated a bitter principle resolvable into sugar and *solanin*, $C_{43}H_{69}NO_{16}$. Solanin itself appears to be a glucoside. D. Gruelin and other chemists regard it as a conjugated compound of sugar and a crystallisable alkaloid *solanidia*, $C_{25}H_{39}NO$. Strong hydrochloric acid converts this into an amorphous basic substance, *solanicine*, $C_{50}H_{76}N_2O$. The quantity of solanin in dulcamara is very small.

Action and Uses.—Observations on the action of solanin are very meagre. From the accounts of Clarus, L. von Praag, and Schroff, we gather that it is a local irritant, producing heat and dryness of the throat, and sometimes vomiting, and as a remote effect, vertigo. The effects on man appear to be both slight and indefinite; and with respect to dulcamara itself, I have been unable to obtain from any part of the plant, given in very large doses, the least indication of physiological action (see *St Thomas's Hospital Reports*, 1875). Garrod also comes to the same conclusion. If our Pharmacopœia is to attain a respectable position as a summary of sound scientific deduction in reference to the objects of which it treats, such plants as dulcamara must be forthwith expunged, and care exercised to prevent the admission of remedies which would properly claim no attention if they were divested of the official sanction which a place in the Pharamacopœia implies. If the compilers of this work do not aspire to give it a proper place in medical science, then it would perhaps be well, for the benefit of those who are easily persuaded, if they would assert the privilege of editors, and disclaim all responsibility for the behaviour of the drugs they prescribe.

2. **Infusum Dulcamaræ**, *P.B.* *Infusion of Dulcamara.*

The fluid obtained by infusing 1 ounce of *bruised dulcamara* for an hour in 10 fluid ounces of *boiling water.*

Uses.—Like sarsaparilla, it is supposed to be beneficial in gout, rheumatism, and chronic skin diseases.

Dose.—1 to 2 fluid ounces.

CONVOLVULACEÆ, *R. Brown.* Bindweeds.

These are for the most part twining plants, with a milky purgative juice. The monopetalous plicate corolla, albuminous seeds, and curved embryo are features which link them to the Solanaceæ, which are distinguished by a dicarpellary fruit.

EXOGONIUM PURGA, *Bentham.* The Jalap Plant.

Jalap has been known to Europe since 1609, having been introduced into England from the Mexican town of Jalapa, whence its name. Jalap, as long since stated by Humboldt (*New Spain*, vol. iii. p. 36), or the true "*Purga de Xalapa*, delights in a temperate climate, or rather an almost cold one, in shaded valleys, and on the slopes of mountains." The jalap plant seems to have been first sent from Mexico by Dr Houston; at least, seed sent by him produced a plant which Miller has described in the 6th ed. of his *Gardeners' Dict.* as having smooth leaves. In 1827, Dr Coxe received from Xalapa several growing roots of the jalap plant, which Mr Nuttal described by the name of *Ipomœa Jalapa*, in the *American Journ. of Med. Sc.* v. p. 300, Feb. 1829.

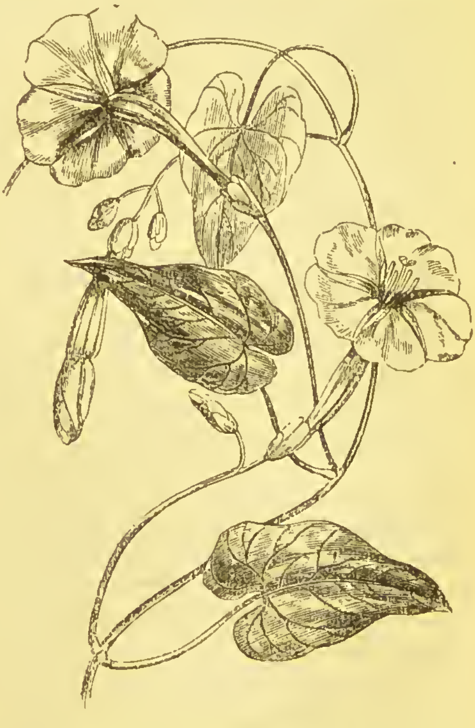

Fig. 77.—*Exogonium purga.*

The plant is now grown in the open air in botanical gardens in the south of England, and on the Continent. Dr Royle, by the liberality of the Hort. Soc. and of Dr Balfour, was enabled to send the roots to the Himalayas. It now grows freely on the Neilgherry hills.

Characters.—Root perennial, ovate or pyriform, externally brownish coloured, internally white, with numerous long fibres. *Stem* twining, brownish, round, and smooth. *Leaves* on long foot-stalks, cordate-ovate, acuminate, entire, very smooth. *Peduncles* axillary, 2-flowered. *Calyx* without bracts; *sepals* 5, obtuse, mucronate, with 2 of them external. *Corolla* crimson or a light-red, with a long rather clavate tube, four times longer than the calyx; limb undulated, with five plaits; lobes obtuse, sub-emarginate. *Stamens* 5; *filaments* smooth, unequal, longer than the tube of the corolla, with white, linear, exserted anthers. *Stigma* capitate, deeply furrowed. *Capsule* 2-celled; cells 2-seeded.

Habitat.—The eastern declivity of the Andes of Mexico, at an elevation of about 6000 feet, where the climate is very wet.—*Nees and Eberm.* Sup. 3, t. 13; *Zuccarini, Plant.* Nov. fasc. 1, t. 12; *Bot. Mag.* vol. lxxiii. pl. 4280.

The tubers are dug up by the natives throughout the year, but chiefly in the spring, about the time of the appearance of the young shoots, and are dried in nets over a charcoal fire.

1. **Jalapa,** *P.B. Jalap.*

The dried tubers of the plant above described, imported from Mexico.

Characters and Constituents.—Varying from the size of a nut to that of an orange, ovoid, and sometimes pointed at one end, the larger ones often cut into halves, very dense and hard, dark-brown, wrinkled, and presenting a number of transverse scars like stomata, exhibiting when cut a compact yellowish-grey surface, with dark brown concentric circles. The tubers are extremely tough and horny, unless they are very old, when they become more brittle, and the fracture is somewhat resinous. The powder is a light greyish-brown, the odour sourish and smoky, the taste mawkish, leaving a slightly acrid impression.

According to Guibourt, 100 parts of the root contain 17·65 of *resin*, which is the essential constituent; *sugar*, about 20 parts; *starch*, 19; *cellulin*, 21·60; *gum*, 10·12.

The resin constitutes the resina jalapæ of the Pharmacopœias; it is obtained in the manner described below.

Substitutes.—The roots of *Ipomœa orizabensis*, Ledanois (*Orizaba root, Purgo macho*), and that of *I. simulans*, Hanbury (*Tampico jalap*), are largely employed to adulterate the proper jalap roots, and the resin of the former is often substituted for jalap resin.

Orizaba root.—*Male jalap* occurs in irregular, squarish, block-like pieces, being the divided portions of a large root; or entire and spindle-shaped, not spherical like jalap. In texture and composition it agrees with jalap root. The resin (*jalapin*, $C_{34}H_{56}O_{16}$) is colourless, amorphous, translucent, and *wholly soluble in æther*. Chemists regard it as identical with resin of scammony, and it has the same purgative effects. This resin appears to be as abundant in the root as jalap resin, and orizaba root is probably as valuable therapeutically as jalap.

Tampico jalap, according to the late Mr Hanbury, has been recently imported in considerable quantities. It resembles true jalap, but the roots are generally smaller, more elongated, shrivelled, and corky-looking, and want the transverse scars which are seen on jalap root. It is impossible, however, to distinguish many pieces from true jalap, with which it agrees in odour and taste (*Hanb. and Flück. Pharm.* p. 402). It yields from 10 to 15 per cent. of purgative resin, which is *wholly soluble in æther.*

2. **Resina Jalapæ**, *P.B.* *Resin of Jalap.*

Preparation.—Digest 8 ounces of *jalap* in coarse powder with 16 fluid ounces of *rectified spirit* in a covered vessel, at a gentle heat, for twenty-four hours; then transfer to a percolator, and, when the tincture ceases to pass, pour into the percolator successive portions of rectified spirit until the jalap is exhausted. Add to the tincture 4 fluid ounces of *water*, and distil off the spirit by a water bath. Remove the residue while hot to an open dish, and allow it to become cold. Pour off the supernatant fluid from the resin, wash this two or three times with hot water, and dry it on a porcelain plate by a stove or water bath.

Characters and Composition.—In dark brown opaque fragments, translucent at the edges, brittle, breaking with a resinous fracture, readily reduced to a pale brown powder, sweetish in odour, leaves an acrid sensation in the throat; easily soluble in rectified spirit, only partially so in æther (thus distinguished from the resin of orizaba and tampico roots), and insoluble in oil of turpentine (absence of common resin). A solution in alcohol does not turn the cut surface of potato peeling blue (absence of guaiacum). About 8 per cent. of the crude resin is soluble in æther and in chloroform; and, according to Kayser, it solidifies in contact with water into a mass of crystalline needles. The insoluble portion of the resin is called *convolvulin*, for which Kayser gives the formula $C_{31}H_{50}O_{16}$. It is colourless, melts at 300°, and is insoluble in ammonia and in oil of turpentine. It readily dissolves in the fixed alkalies which convert it into convolvulic acid,—an amorphous substance soluble in water. Treated with nitric acid, convolvulin is resolved into oxalic and ipomœic acid which is isomeric with sebacic acid ($C_{10}H_{18}O_4$). Convolvulin is the chief, if it be not the sole, purgative constituent of the crude resin.

Action and Uses.—Jalap is a powerful, very certain, and speedy drastic purgative, and when judiciously employed it is a safe remedy both for children and adults. A moderate dose, taken upon an empty stomach, induces two or three easy and copious watery stools within two or three hours, and this is not followed by any subsequent irritation. Before the medicine has left the stomach, and in irritable states of the viscus, it sometimes produces nausea and occasionally vomiting. It rarely produces griping, and is much less irritant than gamboge or podophyllum when an eliminative action from the alimentary canal is required, as in renal, hepatic, or cardaic dropsies. In plethora of the abdominal viscera, and in gout, jalap is a most appropriate and valuable remedy. It is also a very suitable and efficacious purgative for the removal of lumbricus and ascarides. Like all other strong purgatives it may be given to produce counteraction in cerebral inflammation.

Dose.—Of the powdered root, 10 to 20 grains; of the resin, 1 to 3 grains.

3. **Extractum Jalapæ,** *P.B. Extract of Jalap.*

Macerate 1 pound of *jalap* in coarse powder in 4 pints of *rectified spirit* for seven days; press out the tincture, then filter, and distil off the spirit, leaving a soft extract. Again macerate the residual jalap in 1 gallon of water for four hours, express, strain through flannel, and evaporate by a water bath to a soft extract. Mix the two extracts, and evaporate at a temperature not exceeding 140° to a proper consistence.

By this process the resin and the inert matter soluble in water are separately extracted. They are mixed together. The result of the process is merely the elimination of about 35 per cent. of starch and cellulin, the yield of extract being about 65 per cent. The admixture of the inert saccharine and gummy matter with the resin is properly regarded as an advantage in causing the separation of the particles of resin, and thus facilitating its action, while it renders it less liable to produce local irritation. Since, however, the finely comminuted particles of vegetable tissue are much more suitable for this purpose, because, being insoluble, they allow of a more ready permeation of the fluids, it follows that the crude jalap powder is a better preparation than the extract. This conclusion is further justified by the largeness of the dose of the extract.

Dose.—5 to 15 grains.

4. **Tinctura Jalapæ,** *P.B. Tincture of Jalap.*

Prepared by exhausting 2½ ounces of *jalap* in coarse powder with 1 pint of *proof spirit* in the manner directed for Tinctura aconiti, and obtaining 1 pint of the tincture.

Dose.—½ to 2 fluid drachms, as an adjunct to other purgatives to increase their action.

5. **Pulvis Jalapæ compositus,** *P.B. Compound Jalap Powder.*

A sifted mixture of 5 ounces of powdered *jalap*, 9 ounces of *acid tartarate of potash*, and 1 ounce of powdered *ginger.*

This is a very useful form for the exhibition of jalap, and is especially serviceable in dropsies. The acid tartrate of potash chiefly serves the purpose of sulphate of potash in compound ipecacuanha powder, viz., that of spreading out the particles of the active constituent.

Dose.—20 to 60 grains.

CONVOLVULUS SCAMMONIA, *Linn.* The Scammony Plant.

The milky juice of the root of this plant has been well and widely known from the time of Theophrastus. The Arabs call it *Suk* *moonya.* The plant itself very much resembles our *C. arvensis.* It is a native of Asia Minor, the Grecian Archipelago, and Southern Russia.

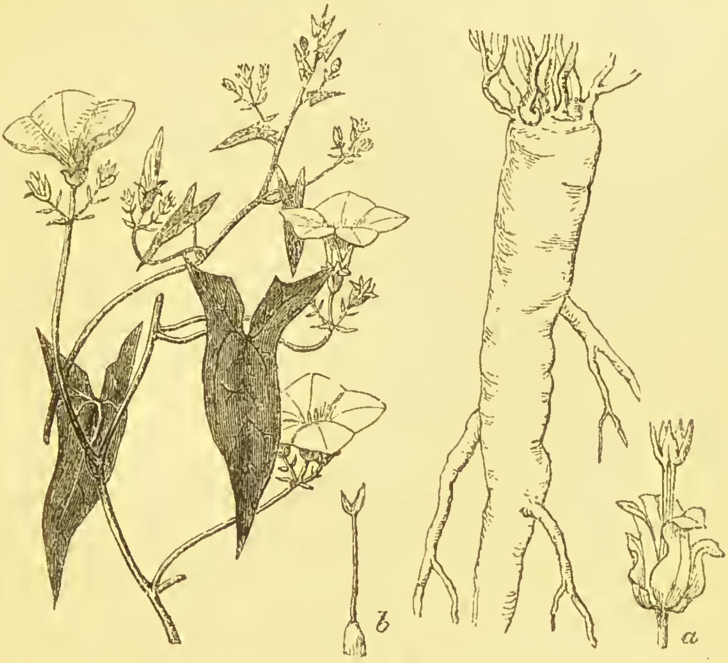

Fig. 78.—*Convolvulus Scammonia.* *a*, sepals and stamens; *b*, style and stigmas.

Characters.—Root perennial, tapering, 3 to 4 feet long, and from 9 to 12 inches in circumference, fleshy, and abounding in acrid milky juice. *Stems* numerous, annual, round, slender, smooth, twining over neighbouring plants or trailing on the ground. *Leaves* petioled, quite smooth, entire, oblong, arrow-shaped, truncate, and angular at the base, with acute spreading lobes. *Peduncles* axillary, solitary, 3-flowered, about twice the length of the leaves. *Sepals* rather lax, smooth, ovate-obtuse, with a reflexed point. *Corolla* of a pale sulphur-yellow colour. *Stamens* 5, erect, converging, about a third the length of the corolla. *Style* equal to the stamens. *Stigmas* white, oblong, erect, parallel, distant. *Ovary* 2-celled, 4-seeded. *Capsule* 2-celled, 4-seeded. —*Woodv. Med. Bot.* pl. 86 ; *Steph. and Church*, pl. 60.

The fresh root is laden with an acrid milky juice, which exudes when it is wounded, and dries up to a rich yellowish-brown transparent gummy mass.

1. **Scammoniæ radix,** *P.B.* *Scammony Root.*

The dried root of the plant above described, from Syria and Asia Minor.

Characters and Constituents.—Long conical woody roots, in shape resembling a carrot, and often spirally twisted, sometimes 3 inches in diameter at the crown, brown without, white within, slightly odorous, tasteless, tough, and resinous. Æther agitated with the powder and evaporated leaves a residue having the properties of scammony resin.

100 parts of the dried root contains, according to Manquart, 4·12 of resin (the active constituent of the root), 5·8 of gum, 24·48 of sugar, starch, and extractive; the remainder being cellulin and salts.

2. **Scammoniæ resina,** *P.B.* *Resin of Scammony.*

Prepared from the coarsely powdered root in the manner prescribed for the separation of resin of jalap.

It may also be obtained in a similar way from scammony.

Characters, Composition, and Tests.—In brownish translucent pieces, brittle, resinous in fracture, of a sweet fragrant odour; prepared from the root. It cannot form singly an emulsion with water (thus distinguished from scammony). Its tincture does not render the fresh cut surface of a potato blue (absence of guaiacum). Æther dissolves it entirely (thus distinguished from resin of jalap).

This resin is homologous with convolvulin, and is identical with *jalapin*, the purgative principle of orizaba root or male jalap (see p. 502). Jalapin is affected by acids and alkalies in the same way as convolvulin, and the decomposition products are homologous or identical with those of convolvulin.

3. **Scammonium,** *P.B.* *Scammony.*

A gum-resin obtained by incision from the living root of the plant above described, chiefly from Asia Minor, Smyrna.

According to Mr Maltass (*Pharm. Journ.* xiii. 1st series, p. 264) it is thus produced. The earth is removed for the depth of three or four inches from around the root of the plant when in flower. The root is then cut through about three inches below the crown, and a mussel shell placed below the upper portion to catch the milky juice which immediately flows. The shell is left till evening, and then removed. Sometimes the *gala* is allowed to dry spontaneously in the shell; but usually the contents of the shells are emptied into one vessel, and set aside in quantities of a pint or more, and allowed to evaporate spontaneously, during which the fluid undergoes fermentation, and acquires a sour and cheesy odour, and a darker colour than the shell or *virgin* scammony, and often exhibits a porous or bubbly structure, indicating the previous extrication of gas.

Characters, Composition, and Tests.—In flattish irregular masses about $\frac{3}{4}$ inch thick; ash-grey and rough externally; fresh fractures resinous, splintery, shining, black when dry; odour and flavour cheesy; causes when chewed a slight pricking sensation in the fauces; easily triturated into a dirty-grey powder, and converted with water into a smooth emulsion. It does not effervesce with hydrochloric acid (absence of chalk). Boiling water agitated with the powder, cooled and filtered, does not strike a blue colour with tincture of iodine (absence of starch). Æther removes from 80 to 90 per cent. of resin (*jalapin*), the remainder being chiefly soluble gum and a little moisture.

Adulterations.—This drug is much adulterated. The "scammony makers" of Smyrna dilute it sometimes to the extent of 150 per cent. with starch, flour, chalk, and ashes; and here in England guaiacum is used for the same purpose. The tests above given under 2 and 3 easily indicate these adulterations.

Action and Uses.—The properties of scammony are identical with those of jalap. Of the two resins, that of scammony is regarded as the more powerful, but I doubt whether this view is a correct one.

Dose.—Of the resin, 3 to 8 grains, of the gum-resin (scammony), 5 to 10 grains.

Pharmaceutical Uses.—A constituent of Pilula colocynthidis composita and P. colocynth. et hyoscyami, Pulvis scammonii compositus, and the following:—

4. **Mistura Scammonii,** *P.B.* *Scammony Mixture.*

Prepared by triturating 4 grains of *resin of scammony* with a little *milk*, gradually adding more milk until an uniform emulsion measuring 2 fluid ounces has been obtained.

A tasteless purgative draught, well adapted for children.

Dose.—$\frac{1}{2}$ to 2 fluid ounces for a child or delicate person.

5. **Confectio Scammonii,** *P.B.* *Confection of Scammony.*

Preparation.—Rub together 3 ounces of finely powdered *scammony*, 1$\frac{1}{2}$ ounce of finely powdered *ginger*, 3 fluid ounces of *syrup*, and 1$\frac{1}{2}$ ounce of clarified *honey*, then add 1 fluid drachm of oil of caraway, and $\frac{1}{2}$ fluid drachm of oil of cloves, and mix.

Not quite so agreeable a mixture as "Tamar Indien."

Dose.—10 to 30 grains.

6. **Pulvis Scammonii compositus,** *P.B.* *Compound Scammony Powder.*

A sifted mixture of 4 ounces of powdered *scammony*, 3 ounces of powdered *jalap*, and 1 ounce of powdered *ginger*.

A mixture which implies (as does also No. 7) a difference between the action of scammony and jalap that does not exist.

Dose.—10 to 20 grains.

7. **Pilula Scammonii composita,** *P.B.* *Compound Scammony Pill.*

Preparation.—Add 1 fluid ounce of *strong tincture of ginger* and 2 fluid ounces of *rectified spirit* to 1 ounce each of *curd soap*, *resin of jalap*, and *resin of scammony*, all in powder and previously mixed, and dissolve with the aid of a gentle heat; then evaporate the spirit by the heat of a water bath until the mass has acquired a suitable consistence for forming pills.

Dose.—5 to 15 grains, in cases where aloes is objectionable.

PHARBITIS NIL, Choisy, the *Convolvulus Nil* of Linnæus, an annual common in India and the tropics generally, and resembling the major convolvulus (*Pharbitis hispida*) of our gardens; yields black seeds (*Kala-dana*) about $\frac{1}{4}$ inch long, which are employed in the Pharmacopœia of India as a substitute for jalap. The dose of the powdered seed is from 30 to 40 grains, and of the resin (*pharbitisin*), which is prepared from the seeds in the manner directed for resin of jalap, from 5 to 8 grains.

IPOMŒA TURPETHUM, R. Brown, furnishes the turbith root of old pharmacologists, which has been employed in the East as a purgative since the time of Avicenna, yields about 10 per cent. of resin, which agrees in its action with resin of jalap.

ARGYREIA SPECIOSA, Choisy, is another common Indian plant. The leaves are used by the natives as a rubefacient and vesicant.

GENTIANACEÆ. The Gentian Family.

These plants are botanically allied to the Solonaceæ and Convolvulaceæ. They are characterised by bitterness, a quality which is diffused through the whole plant.

GENTIANA LUTEA, *Linn.* Yellow Gentian.

This is a handsome plant, native of grassy spots in the mountainous regions of Central Europe, as far north as Thuringia. The Greeks and Arabs were both familiar with gentian. It derives its name from Gentius, a king of the Illyrians.

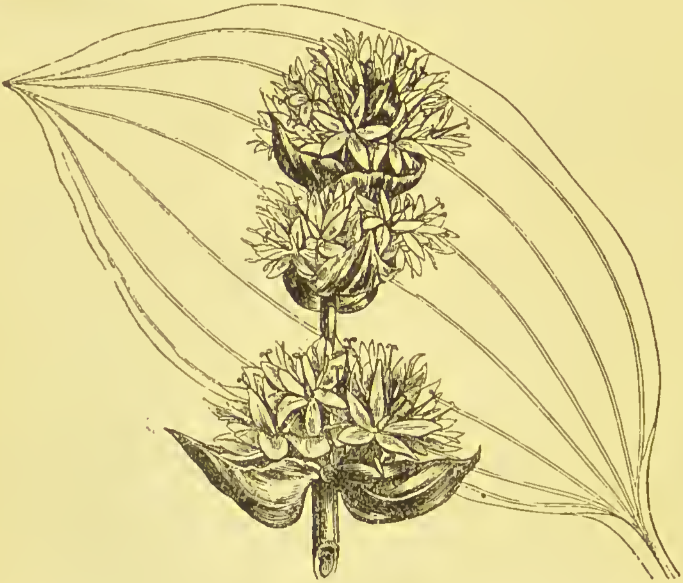

Fig. 79.—*Gentiana lutea.*

Characters.—*Root* perennial, often forked. *Stem* straight, 2 to 3 feet high. *Leaves* opposite, ovate-oblong, 5-nerved; stem leaves sessile, ovate-acute; those supporting the flowers cordate, amplexicaul, concave, all of a pale glaucous-green colour. *Flowers* in an interrupted spike of whorls, large, of a brilliant yellow. *Calyx* membranous, spathe-like, 3 or 4-cleft. *Corolla* twisted in æstivation, with 5 or 6 green glands at its base, 5 or 6-parted. *Stamens* 5; anthers straight, subulate. *Stigmas* 2, revolute. *Ovary* and capsule fusiform, 1-celled. *Seeds* roundish, compressed, with a membranous border. *Habitat,* the Alps, Apennines, and Pyrences, and other mountains of Europe.—*Esenb. and Eberm.* t. 199; *Steph. and Church,* pl. 132.

Other species also yield some of the gentian of commerce, as the Alpine species, *G. purpurea, punctata,* and *pannonica;* while in the Himalayas *G.*

Kurroo yields a similar product. *G. purpurea* is thought to yield the kind of root which is sometimes sold under the name *radix gentianæ rubræ.*

The root is supplied from Germany and Switzerland. France is chiefly supplied from Auvergne.

1. **Gentianæ radix,** *P.B. Gentian Root.*

The dried root of the plant above described, collected in the mountainous districts of Central and Southern Europe.

Characters and Constituents.—From ½ to 1 inch thick, several inches long, often twisted, much wrinkled, or marked with close transverse ridges; brown externally, yellow within, tough and spongy; taste at first sweet, afterwards very bitter.

Gentian root is free from starch; it contains from 12 to 15 per cent. of uncrystallisable sugar, a large proportion also of pectin, a little volatile oil and fat, and two essential crystalline bodies, *gentian bitter*, or *gentiopicrin*, $C_{20}H_{30}O_{12}$, and *gentianic acid*, $C_{14}H_{10}O_5$. The fresh root yields 0·1 per cent. of the former; it is a neutral substance, crystallises in colourless needles; is soluble in water and dilute spirit, and forms a yellow solution with caustic potash, which loses its bitterness after a few days. By boiling with dilute mineral acids, gentiopicrin is resolved into glucose and *gentiogenin*, a neutral, amorphous, yellowish-brown substance. Gentianic acid forms pale yellow, silky, tasteless crystals, which may be sublimed without decomposition. It is but feebly soluble in water and æther, but freely in hot alcohol, and forms crystalline salts with the alkalies. The essential constituent is gentiopicrin, gentianic acid being inert.

Action and Uses.—Those of a pure simple bitter. It is prescribed as a stomachic tonic, in the following forms:—

2. **Extractum Gentianæ,** *P.B. Extract of Gentian.*

Preparation.—Infuse 1 pound of *sliced gentian root* in a gallon of *boiling water* for two hours; boil for 15 minutes; pour off, press, and strain. Then evaporate the liquor by a water bath to a consistence suitable for pills.

Dose.—2 to 10 grains. As it contains but very little astringent matter, it is convenient for prescribing with salts of iron and metallic salts generally.

3. **Infusum Gentianæ compositum,** *P.B. Compound Infusion of Gentian.*

Preparation.—Infuse 60 grains each of *sliced gentian root*, and bitter *orange peel* cut small, and ¼ ounce of *lemon peel* cut small, in 10 fluid ounces of *boiling water* for an hour, and strain.

This is a pleasant tonic stomachic. Owing to the large quantity of pectin which it contains, the infusion is liable to gelatinise after a time when mixed with alcoholic fluids, solution of tannic acid, mineral acids, and metallic salts.

4. **Mistura Gentianæ,** *P.B. Gentian Mixture.*

Preparation.—Macerate ¼ ounce of *sliced gentian root* and 30 grains each of *bitter orange peel* cut small, and *coriander fruit*, bruised in 2 fluid ounces of *proof spirit*, for two hours. Then add 8 ounces of water; macerate again for two hours, and strain through calico. It would be consistent to have called this "Compound," too, or to have eliminated the term from No. 3. By the use of spirit and cold water, solution of the pectin which leads to the speedy decomposition of the infusion, is prevented.

Dose.—½ to 1 fluid ounce.

5. **Tinctura Gentianæ composita**, *P.B.* *Compound Tincture of Gentian.*

Prepared by exhausting 1½ ounce of *gentian root*, cut small and bruised, ¾ ounce of *bitter orange peel*, cut small and bruised, and ¼ ounce of bruised *cardamom seeds*, with 1 pint of *proof spirit*, in the manner prescribed for Tinctura aconiti, and obtaining 1 pint of the tincture.

Dose.—½ to 2 fluid drachms as a cordial stomachic.

OPHELIA CHIRATA. *Grisebach.* Chiretta.

This is the *Kirâta-tikta*, or bitter plant of the Kirâtas, a mountain tribe in the north of India. The plant has long been esteemed by the Hindoos, and it is universally employed throughout the Bengal Presidency, as gentian is in Europe. Other species of Ophelia, and species of other genera, are also employed in India: they are *O. angustifolia*, Don; *O. densiflora*, Griseb.; *O. elegans*, Wight; and *O. multiflora*, Dalz.; *Andrographis panniculata*, Wall.; *Slevogtia orientalis*, Griseb., called small Chiretta, and several species of *Exacum*. All or most of these plants are called Chiretta in the Indian bazaars.

Characters.—Annual, 2-3 feet high, with a single, straight, round, smooth stem. *Branches* generally decussated, nearly erect. *Leaves* opposite, amplexicaul, lanceolate-acute, smooth, 5-7 nerved. *Flowers* numerous, stalked, upper half of the plant forming elegant decussated umbel-like cymes, with 2 bracts at each division. *Calyx* 4-cleft, with sublanceolate persistent divisions, shorter than the corolla. *Corolla* persistent, yellow, rotate, limb 4-parted, spreading, twisted to the right, with 2 glandular hollows protected by a fringed scale upon each segment. *Stamens* 4; filaments subulate, shortly connected at the base; *anthers* cloven at the base. *Style* single. *Stigma* large, 2-lobed. *Capsules* conical, rather shorter than the permanent calyx and corolla, 1-celled, 2-valved, opening a little at the apex. *Seeds* numerous, affixed to two receptacles adhering to the sides of the valves. *Habitat*, Himalaya mountains, of which Nepal is one of the valleys.—*Wallich, Plant. Asiat. Rar.* 3, p. 33, t. 252 (*Gentiana chirata*).

The entire plant is collected when in flower and some of the lower capsules are beginning to ripen, and tied up into bundles weighing about 2 pounds, and two or three feet long.

1. **Chirata**, *P.B.* *Chiretta.*

The entire plant of *Ophelia chirata*, above described, collected in Northern India.

Characters and Constituents.—Stems about 3 feet long, of the thickness of a goose quill, round, smooth, yellowish-brown, with opposite branches; flowers small, numerous, panicled. The whole plant intensely bitter.

According to Höhn, chiretta contains two bitter principles, *chiratin*, $C_{26}H_{48}O_{15}$, and *ophelic acid*, $C_{13}H_{20}O_{10}$, and the dried leaves yield 7·5 per cent. of ash, the stems 3·7, chiefly composed of potassium and calcium salts.

Chiratin may be precipitated by tannic acid. It is an indistinctly crystallisable neutral principle, light yellow, hygroscopic, very bitter; soluble in warm water, in alcohol, and in æther, and resolved into another neutral and amorphous substance, chiratogenin, $C_{13}H_{24}O_3$, and ophelic acid, by the agency of boiling hydrochloric acid. Ophelic acid is an amorphous, viscid, yellow mass, having a faint gentian-like odour, and a very bitter taste. It is readily soluble in water, alcohol, and æther. The aqueous solution precipitates an alkaline solution of oxyde of copper.

Action and Uses.—Those of gentian; than which it is said to be more powerfully bitter.

2. **Infusum Chiratæ**, *P.B.* *Infusion of Chiretta.*

Preparation.—Infuse ¼ ounce of *chiretta*, cut small, in 10 fluid ounces of water at 120°, for half an hour, and strain.

Dose.—1 to 2 ounces.

3. **Tinctura Chiratæ**, *P.B.* *Tincture of Chiretta.*

Prepared by exhausting 2½ ounces of *chiretta*, cut small and bruised, with 1 pint of *proof spirit*, in the manner directed for Tinctura aconiti, and obtaining 1 pint of the tincture.

Dose.—½ to 2 fluid drachms, as a tonic and stomachic.

OTHER MEDICINAL GENTIANACEOUS PLANTS.—1. *Erythræa Centaurium*, Pros., the *ϰενταύϱιον το μίϰϱον*, or small Centaury of Dioscorides, is a good indigenous tonic. All parts of the plant have a pure bitter taste. It may be substituted for chiretta, and used in the same proportions. 2. *Menyanthes trifoliata*, Linn., Buckbean or Marsh trefoil. This is another indigenous plant which has been long used in medicine, and formerly as a substitute for hops in brewing. The stem and long-stalked ternate leaves are quite smooth, and have a very bitter, somewhat nauseous taste. The expressed juice contains, according to Trommsdorf, a very bitter, azotised substance.

LOGANIACEÆ. *Decand.* The Strychnia Family.

This venomous Order is so closely allied to Gentianaceæ, Asclepiadaceæ, and Cinchonaceæ, that it is not possible to define the exact limits between them. Gentianaceæ have parietal placenta, whereas those in Loganiaceæ are curved inwards, to form a 2-celled fruit. Cinchonaceæ have an adherent calyx, and Asclepiads a milky juice and peculiar stigma.

STRYCHNOS NUX-VOMICA, *Linn.* The Nux-vomica Tree.

This is a small tree, with a crooked stem, and corymbs of greenish-white flowers, altogether somewhat resembling our dogwood. It is indigenous to the coasts of most parts of India, Burmah, Siam, and the northern parts of Australia. It is the *Koochla* tree (Sanskrit, *culcka* and *kataka*) of the Hindoos, by whom it has been long used as a medicine. It is the *Izarakee* of Persian Materia Medica, and the *Khaunk-al-kulb*, or dog-killer, of the Arabs.

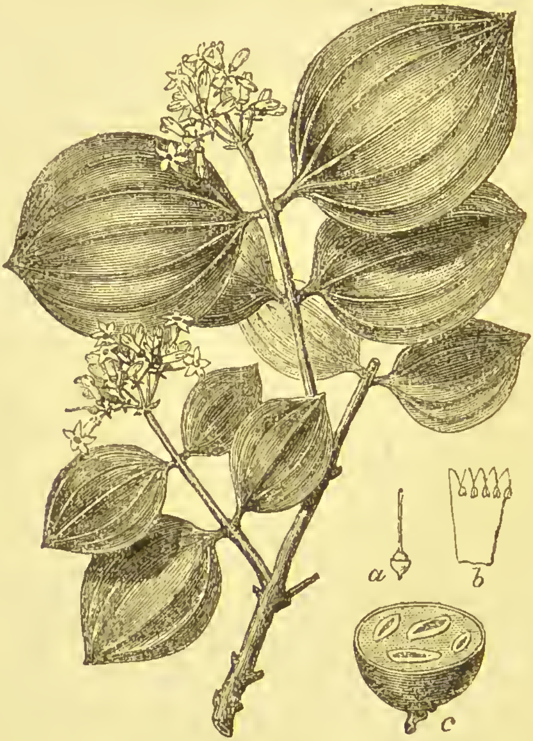

Fig. 80.—*Strychnos Nux-vomica.* *a*. pistil; *b*, corolla and stamens; *c*, fruit.

Characters.—Stem crooked. *Branches* irregular, the young ones long and flexuose, with smooth dark-grey bark. Wood white, close-grained, and bitter. *Leaves* opposite, with short petioles, oval, smooth, and shining, 3 to 5-nerved. *Flowers* small, greenish-white, in terminal corymbs. *Calyx* 5-toothed. *Corolla* funnel-shaped; limb 5-cleft, valvate. *Stamens* 5; filaments short. *Ovary* 2-celled, with many ovules in each cell attached to the thickened centre of the partition. *Style* equal to the corolla in length. *Stigma* capitate. *Berry* round, smooth, about the size of an orange, covered with a smooth, somewhat hard fragile shell, of a rich orange-colour when ripe, filled with a soft white gelatinous pulp, in which are immersed the seeds attached to a central placenta. *Seeds* peltate.—*Roxb. Coromb.* i. t. 4; *Esenb. and Eberm.* 209; *Steph. and Church*, pl. 52.

The whole of the plant is pervaded by strychnia, the greater portion residing in the seed and bark. *Nux-vomica bark* is in flattish or slightly-curved pieces, thick, hard, and compact; fracture dull and brownish; epidermis sometimes displaying a ferruginous, spongy, and friable efflorescence, at other times a yellowish-grey colour, marked with prominent greyish-white spots. Both appearances are due to alterations in the texture of the epidermis, and not to lichens, which are rare. The bark is smooth internally; its powder of a yellowish-white colour, without smell, but having an intense and permanent bitter taste. A drop of nitric acid applied to the external surface turns it of a dark-greenish colour; but if applied to a transverse section or to the internal surface, a dark-red spot is produced.

The bark is unfortunately sold in many shops in Calcutta under the name of *Rohun*, and thus substituted for the febrifuge bark of the *Rohuna tree* or *Soymida febrifuga* (*Beng. Disp.* pp. 247 and 437). In this way, probably, it came to be introduced into England, and not being found saleable, was sent to Holland, and there sold and used as Angustura bark. Dr Ronbach of Hamburgh discovered its poisonous properties, but not before several fatal cases had occurred. Angustura bark somewhat resembles that of strychnia, but the former is *thinner and much more friable*, and is readily known by its *aromatic* and only moderately bitter taste.

1. **Nux-vomica**, *P.B.* *Nux-vomica.*

The seeds of the plant. Imported from the East Indies.

Characters and Constituents.—Nearly circular and flat, about an inch in diameter, and $\frac{1}{6}$th of an inch thick, umbilicated, and slightly convex on one side, covered externally with a drab-coloured, satiny coat, formed of short silky hairs. It is otherwise composed of two circular discs of horny albumin, enclosing, near the margin, a thin, leafy embryo, the position of which is indicated by a minute depression at the circumference corresponding to the extremity of the radicle. The seed is inodorous, and the taste intensely bitter. The powder resembles that of jalap root in appearance. The active properties of Nux-vomica are due to three crystalline alkaloids—*strychnia*, $C_{21}H_{22}N_2O_2$, *brucia*, $C_{23}H_{26}N_2O_4,4H_2O = 394 + 72$, and *igasuria*, which is said by Schützenberger to be composed of nine distinct bases. Strychnia is described below: Nux-vomica furnishes from $\frac{1}{4}$ to $\frac{1}{2}$ per cent. of this base. The quantity of brucia is variable, ranging from 0·12 to 1 per cent. Brucia closely resembles strychnia. It crystallises in colourless, transparent, oblique, rhombic prisms, insoluble in æther; soluble in 150 parts of boiling water, melting at 212°, and forming a blood-red solution with nitric acid, turning to violet on the addition of stannous chloride. Its salts are very bitter; they have the same action as those of strychnia, but are not so powerful. With methyl iodide and æthyl iodide it forms compounds corresponding to those of strychnia, described below. Igasuria was obtained by Desnoix in the mother-liquor from which the other two bases have been precipitated. It may be obtained in silky needles, very bitter, and soluble in 200 parts of boiling water. These bases are combined in the seed with strychnic or igasuric acid, which Ludwig describes as a yellow-brownish, amorphous mass, of strongly acid reaction. The seed contains 6 per cent. of sugar which reduces cupric oxyde in the cold, and 4 per cent. of fat.

2. **Strychnia,** *P.B.* *Strychnia,* $C_{42}H_{22}N_2O_4$ or $C_{21}H_{22}N_2O_2=334$.

Preparation.—This base, formerly called strychnine, is thus obtained:—Subject 1 pound of *Nux-vomica* for two hours to steam in any convenient vessel; chop or slice it, dry it by the vapour bath or hot-air chamber, and immediately grind it. Digest the powder at a gentle heat for twelve hours with two pints of *rectified spirit* and one of *water;* strain through linen, express strongly, and repeat the process twice. Distil off the spirit from the mixed fluids; evaporate the watery residue to about sixteen ounces, and filter when cold. Add now 180 grains of *acetate of lead,* previously dissolved in water, so long as it occasions any precipitate; filter; wash the precipitate with 10 ounces of cold water, adding the washings to the filtrate; evaporate the clear fluid to 8 ounces, and when it has cooled add *solution of ammonia* in slight excess, stirring thoroughly. Let the mixture stand at the ordinary temperature for twelve hours; collect the precipitate on a filter, wash it once with a few ounces of cold water, dry it on the vapour bath, and boil it with successive portions of rectified spirit till the fluid scarcely tastes bitter. Distil off most of the spirit, evaporate the residue to the bulk of about half an ounce, and set it aside to cool. Cautiously pour off the yellowish mother-liquor (which contains the brucia and igasuria) from the white crust of strychnia which adheres to the vessel. Throw the crust on a paper filter, wash it with a mixture of two parts of rectified spirit and one of water, till the washings cease to become red on the addition of nitric acid (absence of brucia); finally, dissolve it by boiling it with an ounce of rectified spirit, and set it aside to crystallise. More crystals may be obtained by evaporating the mother-liquor.

In this process the igasurates of the alkaloids are dissolved out of the powdered seed by the alcohol, the greater part of the brucia and the whole of the the igasuria are precipitated by the acetate of lead, and the strychnia is subsequently precipitated, with a little of the brucia, from the filtered liquid by an excess of ammonia. The strychnia is completely separated from the associated brucia by the processes of crystallisation and washing, the latter being much more soluble both in water and in alcohol than the former.

Characters and Tests.—In right square octohedra or prisms, colourless and inodorous; soluble in 6700 parts of cold and in 2500 parts of boiling water, so intensely bitter that this quality is distinctly perceptible in a solution of 1 part of the salt in 600,000 of water; soluble in boiling rectified spirit and in chloroform, but not in alcohol or in æther. Pure sulphuric acid forms with it a colourless solution, which, on the addition of bichromate of potash, acquires an intensely violet hue, speedily passing through red to yellow. Not coloured by nitric acid (absence of brucia); leaves no ash when burned with free access of air. A few drops of a solution containing $\frac{1}{5000}$ part of a grain, placed on the skin of a frog, produces in about half an hour tetanic convulsions.

Strychnia combines directly with iodine to form a sesquiodide

$(C_{21}H_{22}N_2O_2)_2I_3$, which separates from an alcoholic solution in orange-coloured crystalline scales. Heated by a water bath with *methyl-iodide* or *æthyl iodide*, strychnia forms colourless, bitter crystalline compounds of methyl-strychnium iodide $(C_{21}H_{22}N_2O_2CH_3I)$ and æthyl-strychnium iodide $(C_{21}H_{22}N_2O_2C_2H_5I)$ respectively. They are much less bitter than strychnia and much more soluble in water, and have totally different physiological effects.

Action.—The action of strychnia and its associated alkaloids is simple; they are excitors of the centres of those nerves which are distributed to the striped muscle, excluding the heart from this category. Thus, when given in sufficient doses ($\frac{1}{4}$ to $\frac{3}{4}$ of a grain by the stomach) the whole of the voluntary contractile tissue is thrown into violent spasm, the muscles becoming intensely rigid, curving the body backwards (opisthotonos), forwards (emprosthotonos), or to one or other side (pleurosthotonos). The muscles of respiration are affected equally with those of the limbs, the breathing is suspended, the blood accumlates in the right side of the heart, and the organ becomes greatly excited to relieve itself of the load. This condition of universal cramp is attended with great pain in the muscles and intense distress from suffocation. After some seconds the spasm suddenly gives way, leaving the patient exhausted and terrified. After a short interval, and when the breathing and pulse have resumed their natural rate, a sudden noise, a slight movement, a touch, or even a breath of air, renews the tetanic spasm, which again cramps the whole body and throws it into a fine tremor. The duration of the attack is proportionate to the dose. If a large quantity of strychnia have been taken the fits recur after very short intervals, and each fresh attack continues longer than the one which preceded it until the limit is reached, when the suffocated animal is released from the fatal grasp, and left completely lax and incapable of another inspiration. The heart may be found pulsating several minutes after the respiration has ceased, and its action may be revived by depletion of its right cavities. If the subject be young and the lungs healthy, these organs will be found collapsed. The intelligence remains intact throughout, excepting when the asphyxia is nearly complete.

If the dose be too small to produce a fatal result, the intervals between the paroxysms grow longer, the severity of the spasms becomes less, their duration shorter, and they become gradually reduced to irregular twitchings of the muscles, with slight rigidity or stiffness of some of the flexors or extensors, usually the muscles of the back of the neck, effects which may be induced by the ingestion of the $\frac{1}{12}$th of a grain, or the subcutaneous injection of the $\frac{1}{30}$th.

Schroff, and Crum Brown and T. D. Fraser, have shown that the methyl and æthyl compounds of strychnia above mentioned have an action exactly the reverse of that of strychnia itself,—that is, they cause paralysis of the centres of the voluntary movement without previous excitement, like conium or curare.

Uses.—Strychnia is a direct and powerful tonic to the centres of voluntary or reflex movement, and the conditions on which it exerts a remedial action are of course those which are due to depression of the motor function. Thus it is most beneficial in paralysis from disease of any part of the cranio-spinal axis, and especially in the paraplegia which attends slow progressive atrophy of the spinal cord. In this condition it not only gives strength to the voluntary muscles, but by promoting contraction of the circular fibres of the intestine and the sphincter vesicæ it relieves the attendant constipation and enuresis. Apart from any special lesion of the spinal cord, it is the most valuable remedy that we possess in the condition last named, when the constipation is the result of inertia of the muscular coat of the bowel, and when the incontinence of urine arises from weakness of the vesical sphincter. In partial hemiplegias from debility or atrophic disease of the corpora striata, strychnia is equally serviceable; but when this condition is simply the consequence of cerebral hæmorrhage no benefit can be expected from strychnia, and if, as often happens, there be irritation about the seat of hæmorrhage, indicated by a rigid state of the palsied muscles, this drug is not only useless but injurious. However, when all signs of irritation have passed, strychnia may be of use to encourage healthy contraction in the flaccid muscles. In paralysis agitans, and in chorea and epilepsy, attended by muscular debility, strychnia is sometimes beneficial. As a general nervine tonic it is superior to quinine, and in depression of the reflex function, as in functional aphonia and debility of the sexual function, its beneficial action is usually well marked.

Dose.—$\frac{1}{30}$ of a grain with excess of acid, gradually increased sometimes to $\frac{1}{12}$ of a grain, may be taken twice a-day; subcutaneously, from $\frac{1}{60}$ to the $\frac{1}{30}$ of a grain, neutralised with an acid. On account of its insolubility the alkaloid itself does not appear to be fit for subcutaneous use, forming as it does an insoluble deposit in the connective tissue; and it would be exceedingly dangerous to form an inference as to the dose of a soluble salt of strychnia from the quantity of the uncombined alkaloid which may be thrown into the connective tissue with impunity.

Antidotes.—The whole series of depresso-motor remedies have been recommended to counteract the strychnia spasms. Chloroform and chloral hydrate are undoubtedly appropriate antidotes, for they quiet the patient and at the same time powerfully relax the muscles. Drs Crum Brown and T. R. Fraser recommend the sulphate of methyl strychnia as a muscular relaxer. Calabar bean, and especially conium, are perhaps to be preferred.

3. Liquor Strychniæ, *P.B.* *Solution of Strychnia.*

This is a misnomer, the preparation being a solution of hydrochlorate of strychnia.

Preparation.—Mix 6 minims of dilute *hydrochloric acid* (about $\frac{1}{70}$ of a molecule of real acid) with 4 fluid drachms of *water*, and dissolve 4 grains of *strychnia* (about $\frac{1}{80}$ of a molecule of strychnia) in the mixture by the aid of heat; then add 2 fluid drachms of rectified spirit, and sufficient water that the mixture may accurately measure 1 fluid ounce. 1 fluid drachm contains ½ a grain.

Dose.—5 to 10 minims $= \frac{1}{24}$ to $\frac{1}{12}$ of a grain. For subcutaneous use, for which the solution is well suited, 1 to 2½ minims $= \frac{1}{120}$ to $\frac{1}{48}$ of a grain.

4. **Extractum Nucis-vomicæ,** *P.B.* *Extract of Nux-vomica.*

Preparation.—Reduce 1 pound of *Nux-vomica* to fine powder in the manner directed under strychnia. Exhaust the powder by boiling it with successive portions of *rectified spirit* until the latter comes off nearly free from bitterness. Strain, distil off the spirit, and evaporate by a water bath to the consistence of a soft extract.

Dose.—½ grain to 2 grains.

5. **Tinctura Nucis-vomicæ,** *P.B.* *Tincture of Nux-vomica.*

Prepared by exhausting 2 ounces of *Nux-vomica* reduced to fine powder by the process described under strychnia, with 1 pint of *rectified spirit* in the manner prescribed for tincture of aconite, and obtaining 1 pint of the tincture.

Dose.—10 to 20 minims.

Since the proportion of strychnia and brucia in Nux-vomica is liable to a variation of at least 50 per cent. it is desirable, apart from the inconvenience of having useless repetitions of the same drug, that the foregoing preparations 4 and 5 should be expunged from the Pharmacopœia. It would be difficult to find, in the whole range of the organic materia medica, a more stable body than strychnia. It is the complete essence of the seed, and, since we have it in abundance, the articles referred to are at best but " wasteful and ridiculous excess."

OTHER SPECIES OF STRYCHNOS.—*Lignum colubrinum*, supposed to be an antidote against the poison of venomous snakes, as well as a cure for intermittent fevers, is produced by other species, as *Strychnos ligustrina* and *S. colubrina*. *S. tieute* yields the *Upas tieute* and *Tjettek* of the Japanese, which is an aqueous extract of the bark. *S. toxifera* yields the *woorali* or *ourari* poison of Guyana. *S. pseudo-quina* is employed in Brazil as a substitute for cinchona bark, and the seeds of *S. potatorum*, Roxb., *Nirmulee* of the Hindoos, are employed by them to clear muddy water.

The seeds called *St Ignatius' beans* are frequently used for the extraction of strychnia. They are the produce of the *Strychnos Ignatii*, a climbing shrub indigenous to some of the Philippine Islands. They are about 1 inch long, ovate, triangular, reddish-grey, covered with silvery adpressed hairs; about twenty of them are contained in a pear-shaped fruit. They are intensely bitter, and contain a larger quantity of strychnia than *Nux-vomica*. They have been long used in India, where they are called *Papeeta*.

SPIGELIA MARYLANDICA, *Linn.* Carolina Pink. Perennial Wormgrass.

An herbaceous plant, about a foot high, resembling a Gentian.

Characters.—*Root* perennial. *Stems* simple, erect, quadrangular. *Lea* sessile, ovate, lanceolate-acute, decussate. *Flowers* sessile, in unilateral spikes. *Corolla* funnel-shaped, 5-lobed, æstivation valvate, crimson externally, orange-yellow internally. *Stamens* 5, exserted. *Ovary* 2-celled. *Fruit* capsular, smooth.

The virtues of this plant were discovered by the Cherokee Indians, and made known in Europe about a century since. It is now seldom used in England, but is retained in the United States Pharmacopœia.

Its active properties reside principally in the root, which consists of numerous slender wrinkled fibres attached to a knotty head, resembling serpentary, brownish externally; having a faint smell, and a slightly bitter and acrid taste. The stalks and leaves are usually found attached to the roots. According to M. Feneulle, they yield a fixed and volatile oil, a little resin, a *bitter extractive matter*, supposed to be the active principle, with mucilaginous and saccharine matter, and some salts. The leaves afford the same constituents, but a less quantity of the bitter principle.

Action. Uses.—Anthelmintic. Much used in North America. In large doses it acts as an irritant cathartic, and in poisonous doses as a narcotic; the symptoms being acceleration of the pulse, dilatation of the pupils, flushing, dryness of skin, and talkative delirium. 2 to 20 grains of the powder may be given to a child three or four years old—60 to 120 to an adult; or of the infusion (½ ounce to 1 pint of boiling water), 2 drachms to 1 ounce may be given to a child. A quantity of senna equal to the spigelia is usually added, to insure a cathartic effect. (*Wood and Bache.*) The root of *S. Anthelmia* is similarly employed in Guiana and the West Indies as a remedy for ascarides.

ASCLEPIADACEÆ, *R. Brown.* Asclepias.

These are solanal exogens, with the anthers and stigma consolidated into a column (Lindley). They have acrid properties, and some are emetic and diaphoretic.

HEMIDESMUS INDICUS, *Dec.* Hemidesmus.

This is a smooth twining shrub, indigenous to Ceylon and the Indian peninsula.

Characters.—Leaves opposite, varying from ovate-cordate to lanceolate, acute. *Flowers* small, greenish-purple in small subsessile cymes. *Corolla* rotate, 5-parted. *Stamens* 5. *Anthers* coherent, covering the stigma, but not adherent to it. *Pollen-masses* 4 in each anther, adhering when free to the 5 processes of the stigma.—*Wight, Icon. Plant. Ind. Orient.* vol. ii. plate 594.

1. **Hemidesmi radix,** *P.B.* *Hemidesmus Root.*

The dried root of the plant, imported from India.

Characters.—Yellowish-brown, cylindrical, tortuous, furrowed with annular cracks, having a very agreeable flavour and a fragrant odour, resembling that of the Tonquin bean.

Action and Uses.—Reputed to be tonic, alterative, diaphoretic, and diuretic. It has been long used in India as we use sarsaparilla, in the treatment of syphilitic, scrofulous, and cutaneous diseases.

2. **Syrupus Hemidesmi,** *P.B.* *Syrup of Hemidesmus.*

Preparation.—Infuse 4 ounces of *hemidesmus root* bruised, in 1 pint of boiling water for four hours, and strain. Set it by till the sediment subsides; then decant the clear liquor, add 28 ounces of *sugar*, and dissolve by means of a gentle heat. The product should weigh 2 pounds 10 ounces, and have the sp. gr. 1·335. It is employed as a flavouring ingredient.

Dose.—1 fluid drachm.

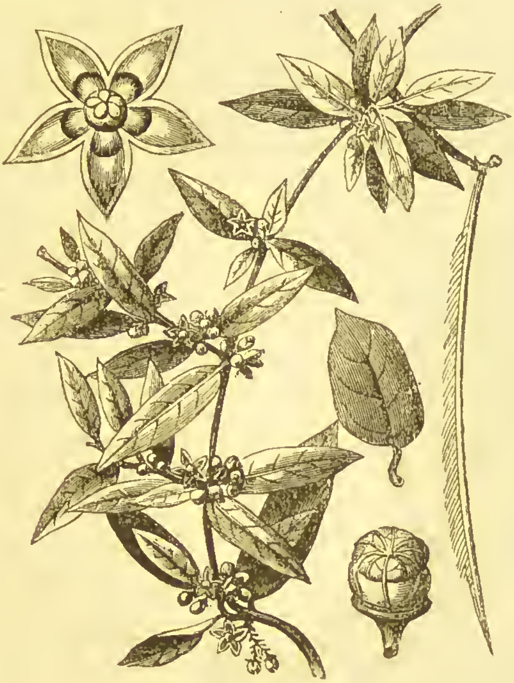

Fig. 81.—*Hemidesmus Indicus.*
An ovate leaf; the flower, the column, and the feathery seed are separately given.

Other Medicinal Asclepiadaceæ. — *Calotropis procera*, R. Brown, and *C. gigantea*, R. Brown, two large shrubs replete with milky juice, yield **Mudar bark**, which was employed in Indian medicine before the Christian era, and is an article of the Pharmacopœia of India. It is the dried bark of the root, and occurs in small flat or arched pieces, brownish externally, yellow-greyish internally, and has a bitter, acrid, mucilaginous taste. It is very light and mealy. It contains mucilage, starch, a bitter principle, and a small quantity of acrid resin soluble in alcohol. In doses of 3 to 5 grains it is tonic, in doses of 30 to 60 grains emetic. *Tylophora asthmatica*, Wight and Arnott, a twining perennial plant common in Ceylon and the sandy regions of Bengal and the Madras peninsula, furnishes the **Folia tylophoræ** of the Indian Pharmacopœia. 3 to 5 grains of the powdered leaves act as a diaphoretic and expectorant; larger doses (25 to 30 grains) are emetic. The Hindoos use it with success in dysentery, and it has been proposed as a substitute for ipecacuanha. *Solenostemma Argel*, Hayne, a small Nubian shrub, furnishes the argel leaves which appear to be purposely mixed with those of senna. They are but slightly purgative, but contain enough irritant matter to occasion griping (Christison).

OLEACEÆ, *Lind.* The Olive Family.

The olive, the ash, syringa (lilac), and privet illustrate this order.

OLEA EUROPÆA, *Lind.* The Olive.

The olive tree, ἐλαία of the Greeks, *Zait* of the Bible, and *Zaitoon* of the Arabs, is one of the most celebrated and useful of trees.

Characters.—A small evergreen, but of a dull aspect; wood hard. *Leaves* with short petioles, ovate-lanceolate or lanceolate, mucronate, of a greyish-green colour above, hoary beneath. *Flowers* white, in short axillary clusters. *Calyx* small. 4-toothed. *Corolla* with a short tube and 4-cleft limb. *Stamens* 2, a little exserted. *Style* short. *Stigma* bifid, segments emarginate. *Ovary* 2-celled, 2-seeded. *Drupe* about the size of a damson, purple-coloured, containing only one sharp-pointed nut. A native probably of Asia, early cultivated in Syria and Greece. The varieties of the olive are numerous. The var. *longifolia* is chiefly cultivated in the south of France and Italy, and the var. *latifolia* in Spain.—*Esenb. and Eberm.* 212; *Steph. and Church*, plate 15.

The leaves and bark of the olive tree have been used in medicine; it produces a peculiar resinous exudation, called *olivile* and *olive gum;* and the bark has been employed as a substitute for cinchona.

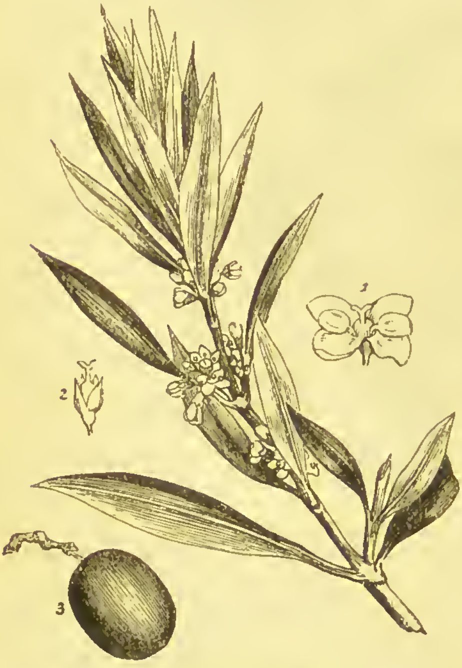

Fig. 82.—*Olea Europæa.*
1, flower; 2, calyx; 3, fruit.

The fruit of the olive—though esteemed, even in its unripe state, as an article of the dessert, for which purpose it is first steeped in an alkaline ley, and then preserved in salt and water—is chiefly valued on account of the bland fixed oil which is stored up in the outer fleshy part. This is obtained either by at once bruising the nearly ripe fruit with moderate pressure in a mill (*virgin oil*), or by the aid of boiling water and greater pressure, or after fermentation has taken place in the olives collected in heaps. By the latter processes *ordinary* and inferior oils are obtained, the worst being employed only as lamp oils or in the manufacture of soap. The finest oils are produced near Aix, Montpellier, Nice, Genoa, Lucca, and Florence. Olive oil is also largely produced in the kingdom of Naples, and exported from Gallipoli, on the east coast of the Gulf of Taronta, whence it is commonly called Gallipoli oil.

Olive oil may be taken as the type of the *fatty* or *fixed oils.*

Oleum Olivæ, *P.B.* *Olive Oil.*

The oil expressed in the south of Europe from the ripe fruit of the plant. It is a pale yellow or light yellowish-green colour, without smell when fresh, having a bland, somewhat sweetish, fatty taste. It is very limpid; sp. gr. 0·910 at 77°. It is insoluble in water, readily dissolved by volatile oils, and by twice its bulk of æther, but requires much more alcohol.* Exposed to the air, it absorbs oxygen and becomes rancid, but does not dry like linseed oil, and is therefore preferred for machinery. At 36° it begins to congeal, and is readily separated at 20° into a solid and fluid portion; the fluid constituent is *olein*, $C_3H_5(C_{18}H_{33}O)_3O_3$; and the solid (formerly called *margarin* from its pearly aspect), often deposited in jars and casks of the oil, is a mixture of *palmitin*, $C_3H_5(C_{16}H_{31}O)_3O_3$, and *stearin*, $C_3H_5(C_{18}H_{35}O)_3O_3$. (For the composition of these bodies see p. 242). The olein forms about 72 per cent. of the oil, and the solid fats 28 per cent. Nitric oxyde and nitrate of mercury convert olive oil into a concrete mass, *elaidin* (see p. 205). When heated with alkalies or oxyde of lead, *saponification* occurs, in which these fatty bodies are decomposed in the manner described at p. 242, and below.

Tests.—Olive oil is frequently adulterated with poppy and other cheaper oils. These are distinguished by exposure to cold. Pure olive oil is completely solidified at 32°. Carefully mixed with $\frac{1}{12}$ of its volume of solution of nitrate of mercury, prepared as for the ointment (see p. 285), it becomes in three or four hours a firm solid, without any separation of liquid oil. If 5 per cent. of any other oil be present, the consolidation is slower and incomplete; if there be 12 per cent., the foreign oil floats on the surface. Oils of poppy, sesame, rape, cocoa-nut, &c., are easily detected by this test.

Varieties.—Provence and Florence oil are the finest; Lucca (imported in 15 gallon stone jars) and Genoa oils are both highly esteemed; Gallipoli oil or cask oil is mediocre; Sicily and Spanish are inferior.

Action and Uses.—Nutrient, emollient, and laxative. It is appropriately given after the ingestion of corrosive or irritant poisons, and is indeed antidotal to the caustic alkalies. But in all these cases it not only alleviates pain, but protects the mucous membrane, and at the same time hinders both the solution (of arsenious acid for example) and absorption of the poison. It is an useful adjunct to liniments, rendering friction both easy and effectual; and as an addition to enemata to facilitate the discharge of scybala, or to soothe and protect an irritable mucous membrane.

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* Pure olive oil is comparatively insoluble in alcohol, but if mixed with two or more volumes of castor oil, which is soluble in alcohol, the two together may then be completely dissolved in rectified spirit, as ascertained by Dr Pereira.

Dose.—As a laxative, 1 fluid ounce. In irritant poisoning it may be given without limit.

Pharmaceutical Uses.—A constituent of Charta epispastica, Cataplasma lini, Enema magnesiæ sulphatis, Linimentum ammoniæ, L. calcis, L. camphoræ: of five of the plasters and five of the ointments; and used in the preparation of the following soaps:—

SOAP. A mixture of Oleate, Palmitate, and Stearate of Soda or Potash.

The manufacture of soap was known to the Romans and inhabitants of India.

Saponification.—The process, as effected by oxyde of lead, has been described at p. 285. The caustic alkalies have exactly the same effect. Oil or fat of any kind, when boiled with an aqueous solution either of potash, soda, or ammonia, forms first a milky and then a clear solution, frothy and viscid, and when concentrated, ropy. The alkali decomposes the fatty compounds of which the oil or fat is composed, setting the glycerin free and combining with fatty acids to form oleate, palmitate, and stearate of the base. From the solution thus formed, these salts, or, to use another term, these soaps are separated in a curd-like form by the addition of a strong solution of sodic chloride, or of caustic alkali, while the glycerin (see p. 353) remains in solution. The soap thus formed is freely soluble in hot water, forming a clear solution, which when concentrated gelatinises on cooling. It is also soluble in hot alcohol, and after evaporation of the spirit is left as a transparent mass. Solutions of the earthy salts (*e.g.*, calcium sulphate or chloride) decompose the alkali soaps, the alkali attaching itself to the acid or chlorine, while the liberated fatty acid and earth combine to form an insoluble soap, as occurs in washing with hard water. Lead plaster is an insoluble soap of this kind. Advantage is taken of this quality to estimate the relative hardness of natural water (see below).

The two varieties of soap, *hard* and *soft*, are due to the base, soda forming hard soap, and potash soft deliquescent soap.

Action and Uses.—Soap, in the form of glycocholate and taurocholate of soda, is a natural constituent of the bile. Its action is detergent and to some extent demulcent. It is also antacid and diuretic. As an adjunct to aloes, balsams, resins, and fatty principles, and to other active principles compatible with alkalies, it promotes their absorption, and thereby increases their action. Dr Clark has introduced soap as a test of the hardness of water. A solution of 120 grains of curd soap in a gallon of water is standardised by a standard solution of calcium chloride, so that 32 gr. measures of the soap solution correspond to 1000 gr. measures, which represents 16 grains of calcic carbonate in a gallon of water. In applying the test, 1000 gr. measures of the water to be examined are placed in a stoppered bottle, and the soap solution added from a graduated burette until a permanent lather is produced—which of course does not occur until after the whole of the lime has been precipitated with the fatty acids as insoluble soap.

1. **Sapo durus,** *P.B.* *Hard Soap.*

Soap made with olive oil and soda.

Characters.—Greyish-white, inodorous; horny and pulverisable when kept in dry warm air; easily moulded when heated. Soluble in rectified spirit; not imparting an oily stain to paper (absence of uncombined oil). Incinerated it yields an ash which does not deliquesce (absence of potash).

The hard soap usually employed in medicine is *Spanish* or *Castille soap.*

2. **Sapo animalis,** *P.B.* *Curd Soap.*

A soap made with soda and a purified fat, consisting principally of stearin.

Character and Tests.—White or with a very light-greyish tint, dry, nearly inodorous, otherwise agreeing with Sapo durus.

The advantage of this variety is due to a capability of being reduced to powder, which is a convenience in the preparation of some of the articles of the Pharmacopœia and in dispensing other compounds.

Pharmaceutical Uses.—A constituent of Emplastrum resinæ, E. saponis, Extractum colocynthidis compositum, Linimentum potassii iodidi cum sapone, L. saponis, Pilula aloes Barbadensis, P. a. et assafœtidæ, P. a. Socotrinæ, P. gambogiæ composita, P. rhei composita, P. saponis composita, and P. scillæ composita.

3. **Sapo mollis,** *P.B.* *Soft Soap.*

Soap made with olive oil and potash.

Characters.—Yellowish-green, inodorous, of a gelatinous consistence. Soluble in rectified spirit, not imparting an oily stain to paper. Incinerated it yields an ash (carbonate of potash) which is very deliquescent.

Pharmaceutical Use.—A constituent of Linimentum terebinthinæ.

4. **Linimentum Saponis,** *P.B.* *Soap Liniment.*

Preparation.—Mix together 2 ounces of *water* and 18 fluid ounces of *rectified spirit,* add 3 fluid drachms of *oil of rosemary,* 1¼ ounce of *camphor,* and 2½ ounces of *hard soap* cut small. Macerate for seven days at a temperature not exceeding 70° with occasional agitation, and filter. If exposed to a temperature much above 70°, the liniment is liable to gelatinise.

5. **Emplastrum Saponis** and **E. cerati saponis** are given under Lead Plasters, p. 243.

FRAXINUS ORNUS, *Linn.* The Flowering Ash.
FRAXINUS ROTUNDIFOLIA, *Decand.* Round-Leaved Flowering Ash,

These two yield manna. The name manna seems to be derived from the Arabic *mun*, signifying the same thing. But as there are several other sweetish exudations (see *manna*, *Penny Cycl.*) it is difficult to determine when manna was first known and used. There is uncertainty also respecting the species which yields European manna. The flowering ash is the *fraxinus* of the ancients, while the common ash is the *ornus* of Virgil.

Characters.—F. ORNUS (*Ornus Europœa,* Persoon) is a tree about 25 feet high, *Leaves* impari-pinnate, consisting of 7 to 9 stalked, oblong-acute, serrated leaflets, which are hairy at the base of the midrib on the under side. *Buds* velvety. *Panicles* dense, terminal, nodding. *Calyx* very small, 4-cleft. *Corolla* divided to the base into linear segments, which are white and drooping. *Pericarp* a narrow elongated capsule, which does not dehisce, terminated by a flat and obtuse wing. *Habitat,* hilly situations in the south of Europe, especially Calabria, Apulia, and Sicily.—*Fl. Grœca,* i. t. 4; *Steph. and Church,* pl. 53.

F. ROTUNDIFOLIA, Dec. (*O. rotundifolia,* Persoon), has leaflets in 2-4 pairs, smooth, roundish or ovoid, obtusely serrated at the margin, and subsessile. Considered by some to be only a variety of the last. Grows in Calabria and the East.

Manna is obtained chiefly by making incisions into the bark, and inserting leaves, sticks, or straws below them, in the middle of summer and in early autumn. The juice flows out as a clear liquid, and soon concretes on the stem, the leaves, or straws placed to attract and intercept it, and thus forms stalactical or *flake manna.* Some falls on leaves or into vessels placed for receiving it. Several kinds are known in commerce. *Manna in tears* is a pure kind, in bright and roundish white grains; but *flake manna* is chiefly valued and mostly met with in this country. It is obtained from Calabria and Sicily.

Manna, *P.B.* *Manna.*

A concrete saccharine exudation from the stem of the trees above described, cultivated for the purpose chiefly in Calabria and Sicily, and obtained by incisions.

Characters and Constituents.—In stalactiform pieces from 1 to 6 inches long and 1 to 2 inches wide, uneven, porous, and friable, curved on one side, of a yellowish-white colour, with a faint, rather sickly odour, and a sweetish taste. It consists of from 60 to 80 per cent. of *mannite* ($C_6H_{14}O_6$), about 15 per cent. each of *glucose* and *dextrine,* a small quantity of brown resin of disagreeable odour and subacrid taste. The glaucous colour of manna is due to *fraxin* ($C_{16}H_{18}O_{10}$), a faintly astringent bitterish substance which crystallises in colourless prisms soluble in hot water and in alcohol. It resembles æsculin, and, like this substance, furnishes a fluorescent solution. By the action of dilute acid it is converted into *fraxetin* ($C_{10}H_8O_5$) and glucose. The mannite may be extracted by boiling rectified spirit, from which it separates on cooling in colourless, shining rhombic prisms or tables. It melts at 330°, and may with care be sublimed; it is soluble in 6 parts of water, and does not decompose an alkaline solution of cupric oxyde, nor undergo vinous fermentation with yeast. Nitric acid converts it into sugar with the formation of a little racemic acid.

Action and Uses.—A mild laxative for children and delicate persons, and as such used as an adjunct to render more active aperients palatable.

Dose.—60 grains to 1 ounce.

STYRACACEÆ, *Lind.* The Benzoin Family.

In botanical characters these plants approach the Rhamnaceæ and through Ebenaceæ Gentians.

STYRAX BENZOIN, *Dryand.* The Benzoin Tree.

This umbrageous tree, the source of benzoin, is a native of Sumatra, Java, Siam, and Borneo.

Benzoin has long been employed medicinally and as incense in the East. In Bengal it is called by a name (*looban*), which in Persian N.W. India is applied only to olibanum (see p. 382). In works on materia medica it is distinguished by the names of *hussee looban* and *husse-al-jawee* (see *Himal. Bot.* p. 261). The name *hussee* appears to be the original of *assa*, as mentioned at p. 463, and benzoin we know is in old works called *asa dulcis.*

Characters.—*Branches* round, tomentose. *Leaves* alternate, oblong acuminate, smooth above, whitish and tomentose beneath. *Racemes* compound axillary as long as the leaves. *Pedicels* ⅓ as long as the flowers. *Calyx* cup-shaped, obscurely, 5-toothed. *Corolla* grey, 5-partite. *Stamens* 10, filaments coherent at the base into a short tube. *Ovary* adherent at the base, ovoid pubescent, incompletely 3-celled. *Style* filiform. *Ovules* indefinite.—*Phil. Trans.* vol. lxxvii. pl. 12; *Esen. and Eberm.* pl. 111; *Woodv. Med. Bot.* pl. 102.

Benzoin is obtained in Sumatra by making incisions into the tree in its seventh year. The milky juice which flows first is the purest and most fragrant; it soon hardens on exposure to the air. That which flows subsequently is brownish, and some is scraped out when the tree is cut down and split open, as it is soon killed by the process of tapping. These varieties are in commerce called *head*, *belly*, and *foot* benzoin, and have the relative values to each other of 105, 45, and 18, being esteemed according to their whiteness, semi-transparency, and freedom from admixtures.

1. **Benzoinum,** *P.B.* *Benzoin* (*Gum-Benjamin*).

A balsamic resin, obtained by making incisions into the bark of the tree above described, and allowing the liquid that exudes to concrete by exposure to the air. Imported from Siam and Sumatra.

Characters and Constituents.—In lumps consisting of agglutinated tears, or of a brownish matted mass, with or without white tears embedded in it, almost tasteless, but has an agreeable vanilla-like odour when scratched; gives off when heated a more powerful fragrance and irritating fumes of benzoic acid; it melts at 167°; is soluble in rectified spirits and in solution of potash. It yields from 14 to 20 per cent. of *benzoic acid* (see below), the browner portions of the resin yielding much more than the white. The remainder is composed of amorphous resins. Subjected to dry distillation, benzoin yields its benzoic acid, contaminated with traces of empyreumatic products, amongst which is *Styrol* (see p. 414). Fused with potash, benzoin furnishes among other products 5 per cent. of protocatechuic acid (see Catechu), pyrocatechin, and para-oxybenzoic acid $C_7H_6O_3$ (Hlasiwetz and Barth). Some samples of benzoin yield cinnamic acid, sometimes as much as 11 per cent. It is soluble also in cold sulphuric acid, developing a rich carmine colour, and liberating benzoic acid.

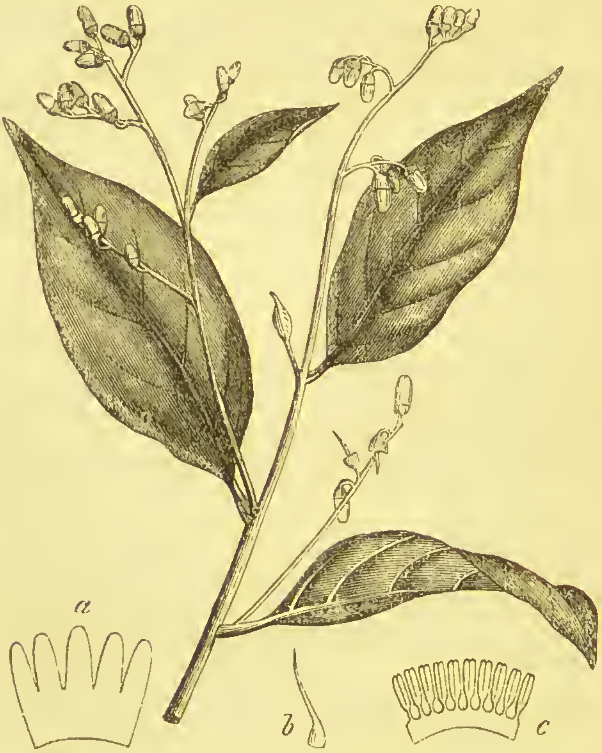

Fig. 83.—*Styrax benzoin.* *a.* corolla; *c*, stamens; *b*, pistil.

Varieties—1. **Siam benzoin** is most esteemed; it is imported in cubical blocks composed of more or less closely aggregated flattened milk-white tears, from 1 to 2 inches long. Sometimes these are embedded in a compact amber brown nearly opaque resin. It is very brittle, and has a sharp fracture. 2. **Sumatra benzoin** also in cubical blocks. It is known by its greyer tinge and the presence of fragments of wood and bark; the proportion of white tears is less than that of the Siam variety, and the odour is weaker and less agreeable.

Action and Uses.—In addition to the effects of benzoic acid (see below), benzoin is stimulant and somewhat acrid, sometimes producing in delicate persons a little gastric irritation. It is rarely given alone, and is very occasionally employed as an expectorant in chronic bronchitis. It is the chief constituent of incense.

2. **Acidum benzoicum,** *P.B. Benzoic Acid,* $HO,C_{14}H_5O_3$ or $HC_7H_5O_2$.

A crystalline acid prepared from benzoin by sublimation. The resin is placed in a shallow iron pot, surmounted by a wooden or pasteboard box, a piece of muslin being interposed between the pot and box to prevent the sublimed acid from falling back into the pot.

Benzoic acid is prepared artificially on a large scale from naphthalin ($C_{10}H_8$). This is converted into phthalic acid ($H_2C_8H_4O_4$) by the action of nitric acid. On heating phthalate of lime with dry slaked lime to between 625° and 660° the phthalate is converted into a mixture of calcic carbonate and benzoate, thus:—

$$2CaC_8H_4O_4 + CaOH_2O = 2CaCO_3 + Ca2C_7H_5O_2.$$

Characters and Tests.—In light feathery crystalline plates and needles, which are flexible, colourless—except when in bulk, a mass of the crystals reflecting a faint rosy tinge; with a benzoin odour, but stronger and not so agreeable as that of the resin, and a hot sub-acrid taste. It is soluble in 200 parts of cold, and 25 of boiling water, but readily so in rectified spirit, and in solution of the caustic alkalis and lime water, from which latter it is precipitated colourless by the addition of hydrochloric acid, unless the solution be very dilute. It melts at 248°, and boils at 462°, and then volatilises, leaving only a slight residue. The vapour is irritating. Kindled in the open air, benzoic acid burns with a smoky flame.

BENZOATES.—Benzoic acid is monobasic, and the characters of the benzoates are well illustrated in benzoate of ammonia (see p. 119). A neutral solution of a ferric salt is used for detecting the presence of benzoic acid in solution. The benzoates of the alkalis when strongly heated yield benzol (see p. 354) and phenyl benzoyl C_6H_5,C_7H_5O, showing the intimate relation between the benzoic and phenic compounds.

Action and Uses.—The changes affecting benzoic acid, and their significance have been already mentioned (p. 119). Locally benzoic acid is irritant, exciting an unpleasant sensation in the throat, and in the form of vapour exciting cough. As a means of eliminating one of the constituents of the biliary acids, glycocol, and as a probable means of arousing the function of the liver, I have given the acid in hepatic congestion and catarrhal jaundice, and, as far as my observations go, benefit has attended its use.

Dose, 10 to 30 grains.

Pharmaceutical Uses.—In the preparation of Ammoniæ benzoas, Tinctura camphoræ composita, and T. opii ammoniata.

3. **Tinctura Benzoini composita,** *P.B.* *Compound Tincture of Benzoin.*

Preparation.—Macerate 2 ounces of *benzoin* in coarse powder, 1½ ounce of *prepared storax*, ½ ounce of *balsam of Tolu*, and 160 grains of *Socotrine aloes* in 1 pint of *rectified spirit* for seven days with occasional agitation, then filter, and add more spirit to make 1 pint of the tincture.

A stimulant expectorant in chronic bronchitis. Under the name of *Friars' balsam* it is very popular as a vulnerary, a piece of soft rag soaked in the tincture being bound round the wound, it is also employed as a stimulant to old ulcers.

Dose.—½ to 1 fluid drachm in the form of emulsion with sugar and mucilage or milk.

Styrax officinale, *Linn.*—This is the source of the *true storax.* It is a native of Greece, Asia Minor, and Syria, and has been imported into Italy and Southern France.

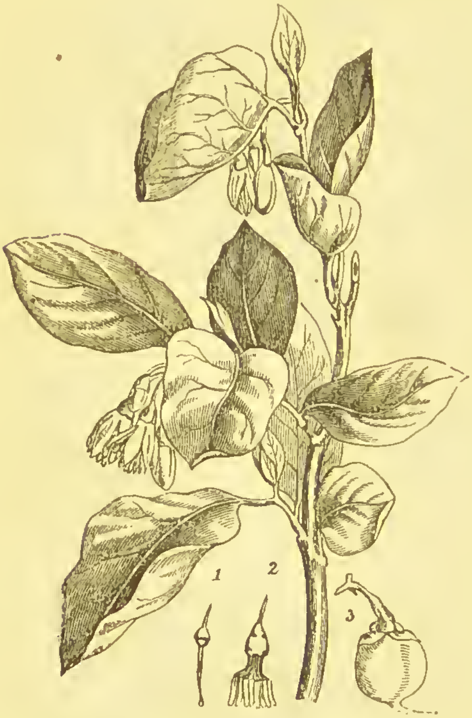

Fig. 84.—*Styrax officinale.* 1, pistil; 2, stamens; 3, fruit. These have been inverted by the artist.

Storax (στύραξ) was well known to, and highly esteemed by, the Greeks. Dioscorides compares the tree producing it with the Quince tree. It is called *asteruk* in the East.

Characters.—A small tree with smooth bark and downy shoots and petioles. *Leaves* ovate-obtuse, of a green colour and shining above, white and downy on the under-surface something like those of the Quince tree. *Flowers* white, in terminal racemes of a few flowers, which resemble those of the orange. *Calyx* downy, cup-shaped, 5 to 7-toothed. *Corolla* externally hairy, with 5 to 7 segments. *Stamens* 10 to 16. Fruit about the size of a cherry, coriaceous, downy, with one or 2 nuclei.—*Esenb. and Ebern.* pl. 210; *Flor. Græc.* t, 375; *Steph. and Church*, pl. 47.

True Storax is a variety of benzoin. It resembles that described above, being a solid resin of balsamic odour. It was formerly obtained in fine tears, and also in masses packed in reeds, hence called *S. calamita*, but it has now dwindled down to the mere sawdust of the tree, with which Dioscorides tells us that the resin was adulterated in his days. The little which is now obtained is used in the churches and mosques of the countries which produce it.

ERICACEÆ, *Endlich.* Heathworts.

Lindley's Pyrolaceæ is here included in this order, which is well illustrated by the common heaths, rhododendrons, and the uva-ursi.

ARCTOSTAPHYLOS UVA-URSI, *Spreng.* Bearberry.

This is a small procumbent, evergreen shrub, indigenous in the northern parts of the British Islands.

Characters.—Leaves coriaceous, obovate, obtuse, quite entire, shining, of a deep green above, lighter colour and covered with a net-work of veins on the under surface, hence reticulated. *Flowers* in terminal clusters of 8 or 10, each supported by 3 small bracts. *Calyx* 5-partite, of a pale red. *Corolla* rose-coloured, ovate-urceolate, 5-cleft, border revolute. *Stamens* 10, enclosed, filaments flattened. *Anthers* compressed, with 2 pores at the apex, and furnished laterally with two reflexed claws. *Ovary* globose, supported by 3 scales. *Style* short. *Stigma* obtuse. *Berry* globose, scarlet, with 5 single-seeded cells. *Habitat*, stony alpine heaths of Europe, Asia, and North America. *Esenb. and Eberm.* pl. 215; *Woodv. Med. Bot.* pl. 70 (*Arbutus uva-ursi*).

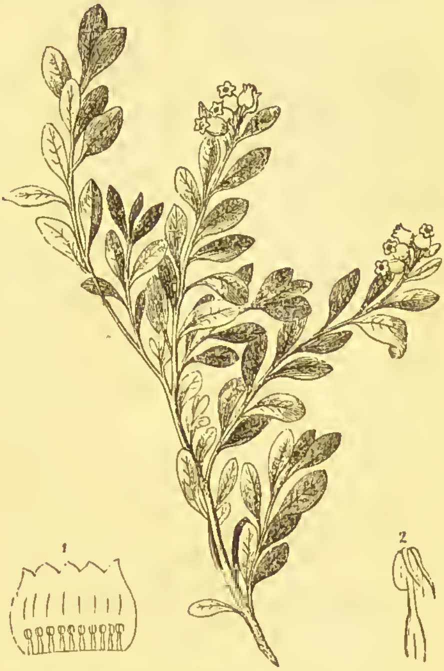

Fig. 85.—*Arctostaphylos uva-ursi.* 1, corolla and stamens; 2, stamen, showing the two claws.

The whole plant abounds in astringency, and this property especially resides in the leaves.

1. **Uvæ-Ursi folia,** *P.B.* *Bearberry Leaves.*

The dried leaves from indigenous plants.

Characters and Constituents.—Obovate, entire, coriaceous, shining leaves, about $\frac{3}{4}$ inch long, convex above, reticulated beneath, with a strong astringent taste, and a feeble hay-like odour when powdered; the infusion gives a bluish-black precipitate with perchloride of iron (tannic and gallic acids).

The leaves contain about 36 per cent. of *tannic acid*, 1·5 of *gallic acid*, *arbutin* ($C_{24}H_{32}O_{14},H_2O$), *pyrocatechin*, *ericolin* ($C_{34}H_{56}O_{21}$), and *ursone* ($C_{20}H_{32}O_2$).

Arbutin is a bitter neutral substance, soluble in hot water and alcohol, but insoluble in æther; by concentrating a decoction of the leaves from which tannic and gallic acids have been removed, it may be obtained in the form of acicular crystals. In contact with emulsin, or by boiling with dilute sulphuric acid, it is converted into hydrokinone ($C_6H_6O_2$), a colourless crystalline body isomeric with pyrocatechin and glucose. Oxydising agents resolve arbutin into kinone ($C_6H_4O_2$), which crystallises in brilliant yellow scales, forming with water a solution which stains the skin yellow; when heated it evolves an irritating vapour of peculiar odour. Ericolin is obtained from the mother-liquor from which the arbutin has crystallised: it exists in minute quantity, is a very bitter amorphous yellow substance, which, when heated with dilute sulphuric acid, is resolved into sugar and ericinol, a colourless oil of agreeable odour, isomeric with camphor. Ursone is extracted from the leaves by æther, in which it is slightly soluble. It is a colourless and tasteless crystalline neutral body, which melts and sublimes unchanged.

Action and Uses.—So far as is known, the action of uva-ursi is entirely dependent on the tannic and gallic acids which it contains. It must, therefore, be regarded as a simple astringent. It has been especially recommended in chronic catarrh of the bladder, but possesses no special influence on this disease. It is a good astringent and convenient for use, and may be given as such in cystitis, diarrhœa, and mucous discharges and hæmorrhages.

Dose of the powder.—20 to 60 grains; but the following is the proper form:—

2. **Infusum Uvæ-Ursi**, *P.B.* *Infusion of Bearberry.*

Prepared by infusing ½ ounce of the *bruised leaves* in 10 fluid ounces of boiling *water* for two hours, and straining.

Dose.—1 to 2 fluid ounces.

CHIMAPHILA UMBELLATA, *Nuttall.* Pipsissewa or Winter Green.

This is a small perennial evergreen indigenous to the woods of Europe, Asia, and North America. It differs but little from our native pyrolas.

Characters.—Leaves, about 1½ inch long, lanceolate-cuneate, being broadest anteriorly and pointed, serrate, coriaceous, shining, on short petioles and arranged in whorls. *Calyx* 5-cleft. *Petals* 5, white, tinged with red, spreading. *Stamens* 10. *Ovary* roundish, obscurely, 5-lobed. *Style* very short. *Stigma* orbicular. *Capsule* 5-celled.—*Steph. and Church*, pl. 93.

The leaves of this plant contain *tannic acid*, bitter extractive, and according to Fairbank a crystalline neutral principle, which he has called chimaphilin.

Action and Uses.—A mild tonic astringent agreeing with uva-ursi, but not nearly so astringent. It is slightly diuretic, and has been recommended in chronic nephritis, cystitis, and gonorrhœa. Dr G. B. Wood regards it as an alterative, and commends its use in scrofula. On account of its reported beneficial influence in this disease, it has acquired the title of "king's cure" in some of the American states.

Dose.—1 to 2 ounces of a decoction containing 1 ounce of the leaves in a pint of water.

LOBELIACEÆ, *Juss.* Lobelias.

The Lobeliaceæ are allied to Compositæ and to Campanulaceæ. They secrete a milky juice, often very acrid and narcotic.

LOBELIA INFLATA, *Linn.* Indian Tobacco.

This plant was first employed by the natives and then by the medical practitioners of the United States, and in this country first in 1829.

Characters.—Annual or biennial. *Root* fibrous. *Stem* erect, angular, the upper part branched and smooth. *Leaves* irregularly serrate, dentate, hairy; the lower ones oblong, obtuse, with short petioles; those towards the middle ovate-acute, sessile. *Flowers* in racemes. *Calyx* smooth, tube ovoid, 5-lobed, segments linear-acuminate. *Corolla* light blue, cleft longitudinally from above, bilabiate, the upper lip narrow, the lower broader, 3-cleft. *Anthers* united into an oblong curved body, the two inferior barbed at the point. *Style* filiform; stigma curved, enclosed by the anthers. *Capsule* 2-celled, ovoid, 10-angled, inflated, crowned with the calyx. *Seeds* numerous, minute, about $\frac{1}{50}$ inch long, ovate-oblong, dark brown, testa reticulated. *Habitat,* a common weed in the United States, from Canada to Carolina.—*Esenb. and Eberm.* pl. 206; *Berg. u. Schmidt, Off. Gewächse.* pl. 1, *a.*

The *L. decurrens* is said to be in common use as an emetic in Peru.

The whole plant when wounded exudes a milky juice, and all parts are possessed of medicinal activity; but, according to Dr Eberle, the root and inflated capsules are the most powerful.

1. **Lobelia,** *P.B.* *Lobelia.*

The dried flowering herb, imported from North America.

Characters and Constituents.—Stem angular; leaves alternate, ovate, toothed, somewhat hairy beneath, capsule membranous, ovoid, inflated, ten-ribbed; herb acrid. Usually in compressed cakes of the chopped herb, cut into oblong parcels, of a greyish-green colour. The microscopic seeds having the characters above given is the best test of the presence of the drug.

The active properties are due to *lobelina,* a volatile alkaloid, of oily and viscid consistence, and having a pungent tobacco-like odour. It is soluble in water, but more freely in alcohol and æther, the latter removing it from an aqueous solution. It forms soluble crystallisable salts with acids, but is readily decomposed by the alkalies. The herb also contains a little volatile oil, resin, and gum. The seeds yield about 30 per cent. of *fixed oil.* Endros finds that the acrid principle is due to *lobelacrin,* which occurs in warty tufts of a brownish colour; it is slightly soluble in water, freely in æther and chloroform, and the solutions have the acidity of lobelia. Boiling with acids or alkalies it is resolved into sugar and *lobelic acid.*

Action and Uses.—Lobelia closely agrees with tobacco in its effects. It produces nausea, followed by violent vomiting and intense prostration, indicated by pallor, feeble pulse, cold sweats, muscular relaxation, and occasionally purging. A burning sensation in the fauces, gullet, and epigastrium is usually experienced. In fatal cases the collapse is complete, lapses into coma, with muscular twitchings, and in some cases convulsions. It is, therefore, a powerful *depressent* and *antispasmodic*, and as such is used in pertussis, spasmodic asthma, and tetanus. It has been employed as an emetic in doses of 20 to 30 grains of the powder, but it is too dangerous a remedy to be thus employed. As an expectorant it is sometimes serviceable in chronic bronchitis. Prescribed by ignorant persons, its effects have been fatal to many.

2. **Tinctura Lobeliæ**, *P.B.* *Tincture of Lobelia.*

Prepared by exhausting 2½ ounces of *lobelia in coarse powder* with 1 pint of *proof spirit* in the manner directed for tincture of aconite, and obtaining 1 pint of the tincture.

Dose.—10 to 30 minims. Half an ounce produces severe vomiting and depression.

3. **Tinctura Lobeliæ ætherea**, *P.B.* *Ætherial Tincture of Lobelia.*

Preparation.—Macerate 2½ ounces of *lobelia in coarse powder* with 1 pint of *spirit of æther* for seven days, with occasional agitation; then strain, press, filter, and add sufficient spirit of æther to make 1 pint.

Dose.—10 to 30 minims.

COMPOSITÆ, *Decand.* The Aster Family.

This Order is very closely allied to Lobeliaceæ, and through them to Campanulaceæ, and to Valerianaceæ. It is distinguished from its allies by the 1-celled ovary and solitary erect seed.

INULA HELENIUM, *Linn.* **Elecampane** (*Inula Campana*).

Elecampane has been prescribed since the time of Hippocrates.

Characters.—*Root* perennial, thick, elongated, brownish externally, white internally. *Stem* erect, 3–4 feet high, round, leafy. *Leaves* large, cordate-ovate, acute, stem-clasping, unequally toothed, downy beneath; radicle leaves stalked, ovate-oblong. *Flower-heads* few together, or solitary, large, bright yellow. *Involucre* imbricated in many rows, outer scales ovate, inner obovate. *Florets* of the ray female, ligulate, 3-toothed, subtubular; those of the disk hermaphrodite, tubular, 5-toothed. *Anthers* with two bristles at the base. *Receptacle* flat, reticulated. *Achenia* quadrangular, smooth. *Pappus* uniform, in one row, composed of roughish setæ. Moist pastures throughout Europe, flowers in July and August.—*Steph. and Church*, plate 49.

The root, when chewed, tastes first glutinous, then bitter and aromatic, and finally a little pungent. It is generally cut into slices for the convenience of drying and preserving. It contains *bitter extractive* 36·7, a peculiar kind of starch, which has been named *inuline* 36·7; *helenin*, a neutral crystalline principle separable, according to Kallen, into a tasteless, odourless crystalline body helenin proper, and elecampane-camphor, also crystalline and having a pepperment odour and taste.

Inulin has the same composition as starch, which it replaces in the roots of the compositæ. It is a white inodorous tasteless powder, turned yellow by iodine. Sparing soluble in cold, but readily in boiling water, from which it partly separates on cooling. Prolonged boiling, or heat above 212°, converts it into a gummy substance. When boiled with dilute acids it is converted into dextrin and lævulose. It precipitates ammonio-plumbic acetate, and is converted into oxalic and acetic acids by nitric acid. By immersing the root in alcohol or glycerin, the inulin is precipitated in crystalline spherules, composed of a dense aggregation of needles, and showing a dark cross like starch granules by polarised light.

Action and Uses.—An aromatic tonic, expectorant, and diaphoretic. It is prescribed in dyspepsia and chronic catarrh.

Dose.—Of the powder, 20 to 120 grains; of the decoction (¾ ounce to 1 pint), 1 or 2 ounces.

ANTHEMIS NOBILIS, *Linn.* **Chamomile.**

This humble perennial is indigenous to England and the central and southern parts of Europe. It is extensively cultivated at Mitcham, and in Saxony, Belgium, and France.

The name 'αυθέμις occurs first in Theophrastus, and that of ἀμαίμηλον in Dioscorides.

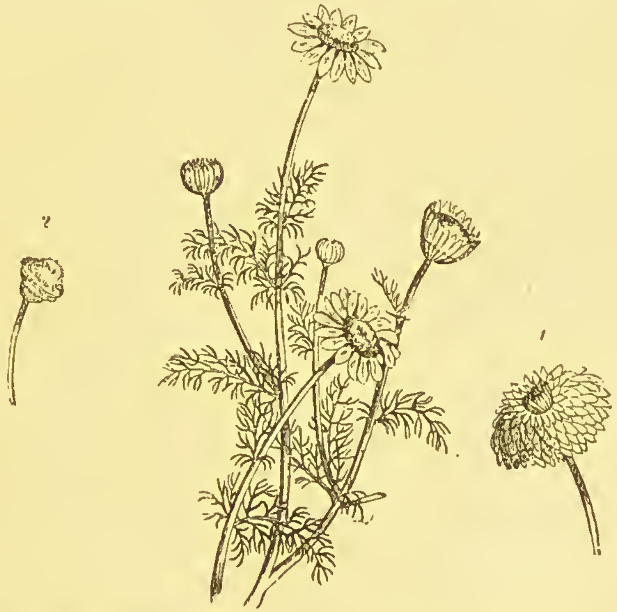

Fig. 86.—*Anthemis nobilis.* 1. double flower; 2. receptacle.

Characters.—*Roots* perennial, with long fibres. *Stems* in a wild state procumbent, when cultivated, erect, about a foot long, much-branched, leafy, round, furrowed, hollow. *Leaves* doubly pinnate; leaflets linear, subulate, slightly hollow. *Flower-heads* terminal, solitary, with a convex yellow disk. *Rays* composed of hermaphrodite, tubular, 5-toothed florets, white, reflexed, or spreading, formed of female florets in one row. *Receptacle* conical, with membranous scales. *Involucre* imbricated in a few rows, scales obtuse hyaline at the margin. *Fruit* obtusely tetragonal, smooth, crowned with an obsolete margin, without pappus.

Two varieties are known. *a.* Flore simplici, fig. 86. *b.* Flore pleno, double chamomile, in which the florets of the disk are converted into white ligulate florets (fig. 86, 1). Flowers in July and August.—*Eng. Bot.* pl. 980.

The whole plant has a strong but pleasant odour, the taste being bitter with a little aroma. These properties are most conspicuous in the florets of the disk, which yield most volatile oil, and therefore the simple flowers are preferable to the double. The double flowers, however, on account of their showiness, are generally preferred by druggists.

1. **Anthemidis flores,** *P.B. Chamomile Flowers.*

The dried single and double flower heads, wild and cultivated.

Characters and Constituents.—The single variety consists of both yellow tubular and white strap-shaped florets; the double, of white strap-shaped florets only—all arising from a conical scaly receptacle. Both varieties, but especially the single, are bitter and very aromatic.

The flowers yield from 1 to 2½ per cent. of *volatile oil*, a very small quantity of a *bitter acid substance*, which Camboulises obtained in the form of needle-like crystals,—others have only succeeded in separating it in the form of a brown extract,—and a little tannic acid. The volatile oil and bitter extract are, of course, the essential constituents. The former is described below. It is distilled at Mitcham from the entire plant, and usually after the best flowers have been gathered.

Substitutes.—The flower heads of *Chrysanthemum Parthenium;* these are distinguished by the flat or only convex (never conical, as in the chamomile) receptacle, and the scales are not so membranous: and the flower heads of *Matricaria chamomilla*, the "common chamomiles" of Germany; in these the receptacle is naked and hollow, and the flowers are single and not bitter.

Action and Uses.—A stimulant aromatic tonic, acting, when given warm and in full doses, as a diaphoretic and emetic. In moderate doses it is stomachic, promoting the digestion and increasing the appetite. It is useful as a diaphoretic and emetic on the access of pyrexia, and as a stomachic in atonic dyspepsia and flatulence.

2. **Oleum Anthemidis,** *P.B. Oil of Chamomile* ($C_{10}H_{16}+C_5H_8O$).

The oil distilled in Britain from the flowers.

Characters and Composition.—Pale-blue or greenish-blue, but gradually becoming yellow, having the aromatic odour and taste of the flowers.

According to Demarçay, the oil is a mixture of *butylic and amylic angelate and valerate.* On gently warming the oil with potash, angelate of potassium is formed, and from which the angelic acid ($HC_5H_7O_2$) may be separated by dilute sulphuric acid. The oil yields 30 per cent. of *angelic acid.* This fatty acid is found in the roots of various species of angelica, occurs in bold striated prisms, which fuse when heated, and sublime unchanged. It is sparingly soluble in cold, but freely in boiling water.

3. **Extractum Anthemidis,** *P.B. Extract of Chamomile.*

Preparation.—Boil 1 pound of *chamomile flowers* with 1 gallon of *water* until the volume is reduced to one-half, then strain, press, and filter. Evaporate by a water-bath until the extract is of a suitable consistence for forming pills, adding 15 minims of *oil of chamomile* at the end of the process.

The oil lost in the process of boiling is replaced towards the end of the operation.

Dose.—2 to 10 grains as a stomachic tonic. It is usually employed as a vehicle for mineral tonics when given in the form of pill.

4. **Infusum Anthemidis,** *P.B. Infusion of Chamomile.*

Prepared by infusing ½ ounce of the *flowers* in a covered vessel with 10 fluid ounces of water for fifteen minutes, and straining.

Dose.—1 to 4 fluid ounces; the latter, when taken warm, may be used as a gentle emetic, or as an adjunct to other emetics.

ANACYCLUS PYRETHRUM, *Dec.* Pellitory of Spain.

The *πυϱέθϱον* of Dioscorides. It has been long employed in Eastern medicine under the name of *akurkurha.* The plant is a native of the north of Africa, whence it has been introduced into the south of Europe.

Characters.—*Root* long, fusiform. *Stems* numerous, procumbent, branched, pubescent. *Radical leaves* spreading, petiolated, rather smooth, pinnatifid; the segments pinnated, with linear tubulate lobes; *stem leaves* sessile. *Branches* one-headed. *Heads* many-flowered. *Involucre* in a few rows, short, somewhat cup-shaped, scales lanceolate, pointed, brown at the edges. *Receptacle* convex, with oblong, obovate, obtuse paleæ. *Florets* of the ray female, sterile, white above and purplish beneath; of the disk, yellow, tubular, with 5 callous teeth. *Achenium* flat, obcompressed, bordered with broad entire wings. *Pappus* short, irregular, toothed.—*Desf. Fl. Atl.* ii. 287; *Nees and Eberm.* 244; *Steph. and Church,* pl. 97.

The root, as described by Desfontaines, in its fresh state is fusiform and fleshy, about the thickness of the finger, brownish-coloured externally and white within. When handled in this state it produces first a sensation of cold, soon followed by heat. It is without odour, but has an acrid pungent taste, and causes a copious flow of saliva. It is imported from the Levant.

Pyrethri radix, *P.B. Pellitory Root.*

The dried root of the plant above described, imported from the Levant.

Characters and Constituents.—In pieces about the length and thickness of the little finger, covered with a thick brown bark, studded with black shining points. Breaks with a resinous fracture, and presents internally a radiated structure. When chewed, it excites a hot prickling sensation in the lips and tongue.

The root contains an *acrid resin* (*pyrethrin*), insoluble in solution of potash; another *resin*, soluble in that alkali, and a yellow *acrid oil*, also soluble in potash (Koene). The root also contains inulin, gum, a little tannin, colouring matter, various salts, and ligneous fibre.

Substitute.—The root of *Anacyclus officinarum*, or African pellitory, an annual plant cultivated in Germany, is used as a substitute for the above on the Continent. It is equally pungent.

Action. Uses.—Irritant and sialogogue. It is sometimes used to relieve toothache, or as a masticatory in palsy of the tongue and relaxation of the uvula.

Tinctura Pyrethri, *P.B.* *Tincture of Pellitory.*

Prepared by exhausting 4 ounces of *Pellitory root* in coarse powder, with 1 pint of *rectified spirit*, in the manner directed for tincture of aconite, and obtaining 1 pint of the tincture.

Use.—Placed on cotton wool, it is used to relieve toothache, and when diluted with 19 parts of water, may be used as a gargle.

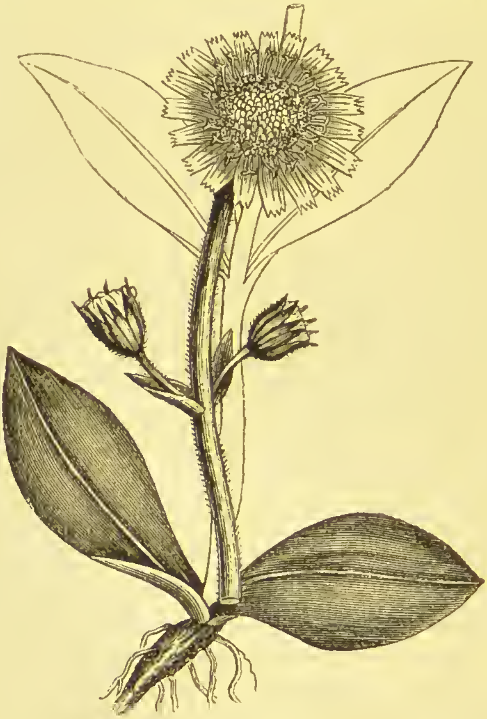

Fig. 87.—*Arnica montana.*

ARNICA MONTANA, *Linn.* **Mountain Arnica. Mountain Tobacco.**

Arnica has long been employed in medicine, though there is no proof that it was known to the Greeks, as inferred by Matthioli. Several dissertations have been written upon its medicinal virtues, from the time of Lamarche (1719) to the present day.

Characters.—A perennial plant, with hairy stems, about a foot high. *Radical leaves* obovate, entire, 5-nerved. *Cauline leaves* in 1 or 2 pairs. *Stems* with 1–3 heads of flowers. *Head* many-flowered, heterogamous. *Florets* yellow, tinged with brown; those of the ray in 1 row, female, ligulate; of the disk hermaphrodite, tubular, 5-toothed. *Involucres* rough, campanulate, in 2 rows, with linear-lanceolate equal scales and glands. *Receptacle* fringed, hairy. Tube of the corolla shaggy. *Style* of the disk with long arms, downy, truncated. *Fruit* cylindrical, hairy. *Pappus* in 1 row of close rigid hairs.—Meadows and mountain places of Middle and Southern Europe.—*Steph. and Church*, pl. 123; *Woodv. Med. Bot.* pl. 17.

The plant, when fresh and bruised, has rather an agreeable odour, which is apt to excite sneezing; the taste of the leaves and flowers is bitter and pungent, of the root-stock bitter and acrid. Some mountaineers smoke it like tobacco. The root and flowers are both used in medicine; the latter are said to be richer in arnicin.

1. **Arnicæ radix**, *P.B.* *Arnica Root.*

The dried rhizome and rootlets of the plant above described. Collected in the mountainous parts of Middle and Southern Europe.

Characters and Constituents.—Rhizome 1 to 3 inches long and 2 to 3 lines thick, cylindrical, contorted, rough, from the scars of coriaceous leaves, and furnished with numerous long slender fibres; has a peppery taste and faintly aromatic odour. The dry roots contain ½ per cent. of *volatile oil*, of sp. gr. ·99, having the composition C_6H_9O (Sigel). The active principle is *arnicin*, $C_{20}H_{30}O_4$ (Walz.), a yellow amorphous substance of acrid taste, slightly soluble in water, freely in alcohol, æther, and alkaline solutions. It is decomposed by dilute acids. The root contains about 10 per cent. of inulin.

Adulteration.—Holmes has met with the roots of *Geum urbanum;* it is easily known by its astringency and absence of acridity.

Action and Uses.—Locally applied, arnica is a feeble irritant; internally it is stimulant and diaphoretic. In large doses it causes some heat in the throat, nausea, and looseness of the bowels, occasionally with griping. It has been recommended in conditions of debility and torpor; but it is far inferior to either elecampane or serpentary. As an external application it is supposed by credulous people to have a marvellous power in promoting the recovery of a bruised or sprained part. The ecchymosis is said to disappear so rapidly, that if we granted the truth of these statements, it would be reasonable to infer that arnica had the power of bleaching the blood.

2. **Tinctura Arnicæ**, *P.B.* *Tincture of Arnica.*

Prepared by exhausting 1 ounce (why not the stereotyped 2½ ounces?) of the *bruised root* in coarse powder with 1 pint of *rectified spirit*, in the manner prescribed for tincture of aconite, and obtaining 1 pint of the tincture.

Dose.—1 to 2 fluid drachms. As a lotion, 1 vol. to 9 of water.

ARTEMISIA, *Linn.*

Generic Characters.—*Heads* discoidal, homogamous, or heterogamous. *Florets* of the ray in one row, usually female and toothed, with a long bifid protruding style; of the disk 5-toothed, bisexual, or by the abortion of the ovary, sterile or male. *Involucral scales* imbricated, dry, scarious at the edge. *Receptacle* without paleæ, flattish or convex, naked or fringed with hairs. *Achenia* obovate, bald, with a minute epigynous disk.—*Dec.*

The species of Artemisia, extending from European to tropical countries, are most of them remarkable for their strong aroma and bitter taste, and have been employed in medicine from the earliest times, as *A. Abrotanum* or southernwood, *A. vulgarus* or mugwort, &c. *A. Dracunculus* or *Tarragon* is employed as a condiment in Europe. According to Lindley, *A. moxa* furnishes the *moxa* of the Chinese. In the Himalayas, the tomentum of *Chaptalia gossypina* is used as amadou.—*Him. Bot.* p. 274.

ARTEMISIA MARITIMA, *Linn.* The Santonica or Wormseed Plant.

According to Besser and Ledebour, two varieties of this plant furnish santonica, α *Steehmanniana* and β *pauciflora.* The species is found in salt marshes of Britain, France, and the Mediterranean, and diffused abundantly throughout Central Europe and Asia, extending from the shores of the Caspian to those of the Baltic. According to Björklund, it is chiefly collected on the vast plains or steppes of the Kirghiz, in Turkestan. It is brought to the great fair at Nishnei-Novgorod, and is thence distributed to Western Europe (*Hanb. and Flückiger*, p. 347).

Characters.—A low tomentose suffruticose aromatic plant. Upper part of tem fastigiate. *Leaves* downy, pinnatifid, the uppermost undivided. *Flower-heads* drooping, in dense thyrsoid panicles, involucral scales oblong obtuse, the inner ones scarious. *Habitat.*—The Don and Lower Volga and the Kirghiz deserts.

1. Santonica, *P.B.* *Santonica.*

The unexpanded flower-buds of an undetermined (see above) species of *Artemisia*, Linn. Imported from Russia.

Characters.—Flower-heads rather more than a line in length and nearly ½ a line in breadth, fusiform, blunt at each end, pale greenish-brown, smooth; resembling seeds in appearance, but consisting of imbricated involucral scales with a green midrib, enclosing four or five tubular flowers; odour strong, taste bitter, camphoraceous. They are neither round nor hairy; that is, they are not intermixed with the flowers of the native *Artemisia vulgaris* (mugwort) or *A. Absinthium* (wormwood). Besides resin, fat, and sugar, the flower-buds yield about 1 per cent. of *volatile oil*, having their characteristic odour and taste. It boils at 347°, and chiefly consists of *cinæbene camphor*, $C_{10}H_{18}O$, which parts with water when heated, and is converted into the dehydrated form, $C_{10}H_{16}$. The essential constituent of the santonica is *santonin*, which exists in the proportion of 1½ to 2 per cent.

2. Santoninum, *P.B.* *Santonin.* $C_{30}H_{18}O_6$ or $C_{15}H_{18}O_3$.

A crystalline neutral principle obtained from santonica.

Preparation.—Boil 1 pound of *santonica* with 1 gallon of *water* and 5 ounces of *slaked lime* for an hour; strain, and boil the flowers again with ½ gallon of *water* and 2 ounces of *slaked lime* for half an hour; strain, and mix the two liquors, filter, and evaporate to 2½ pints. Add to the hot liquid hydrochloric acid in slight excess, and set aside for 5 days. Remove any floating oily matter, decant the fluid, and collect the precipitate on a filter, and wash it with cold water until it is free from acid, and then with a mixture of ½ fluid ounce of solution of ammonia and 5 ounces of water, and lastly with cold water until the washings pass colourless. Press and dry the residue. Boil it for 10 minutes with 60 grains of *purified animal charcoal* and 9 fluid ounces of *rectified spirit*. Filter, and set aside to crystallise. Protect the crystals from the light.

In this process the santonin combines with the lime to form a soluble compound; this is decomposed, and the santonin precipitated by hydrochloric acid, and resinous matters are washed from it by the ammonia water. It is then dissolved in boiling spirit and decolorised. On cooling, the filtered solution deposits the santonin.

Characters and Tests.—In colourless rectangular tabular crystals, inodorous, feebly bitter, fusible, and sublimable at a moderate heat; sunlight renders it yellow. This is a mechanical change due to an alteration in crystalline form, as occurs with red iodide of mercury (see p. 276); scarcely soluble in cold, and sparingly in boiling water, but abundantly in chloroform and boiling rectified spirit; insoluble in dilute acids, entirely destructible by a red-heat with free access of air. According to Hesse, santonin is the anhydride of *santoninic acid*, $C_{15}H_{20}O_4$, a crystalline body which, when heated, is resolved into santonin and water. Heated with an alkali, santonin is converted into *santonic acid*, which is isomeric with santoninic acid, but is not convertible, like it, into santonin and water.

Action and Uses.—Santonin is exclusively used as a vermicide. It appears to have no effect on tæniæ, but it is an effectual remedy against the round worm and the thread worm. In some persons it tinges the field of vision yellow (xanthopsia), so that blue objects look green, and red orange-coloured. It is eliminated changed, and the urine sometimes stains the linen yellow.

Dose.—2 to 6 grains in powder, or solution in oil or borax. I find that 12 grains of santonin dissolve in a boiling solution of 20 grains of bicarbonate of soda in 3 ounces of water, forming a permanent solution.

ARTEMISIA ABSINTHIUM. *Linn.* Wormwood.

This indigenous perennial is the 'Αψίνθιον of the Greeks, and *Afsunteen* of Eastern nations. These terms, however, have been applied to other species.

Characters.—*Root* ligneous, branched. *Stems* numerous, bushy, furrowed, leafy, the whole plant covered with close silky hairiness. *Leaves* alternate, silky tripinnatisect, in many deep, lanceolate, obtuse segments; lower ones on long, the upper on short and broad footstalks. *Floral leaves* simple. *Flower-heads* in leafy, clustered panicles, drooping, hemispherical, heterogamous; the outer scales of the involucre linear, silky; inner roundish, scarious. *Florets* pale yellow, the outer row female. *Styles* deeply cloven. *Receptacle* convex, covered with silky hairs.—Waste ground in various parts of Europe and the north of Asia.—*Eng. Bot.* t. 1230; *Steph. and Church*, ii. 58. Should be collected in July and August, when in flower.

The dried herb or the flowering top has a greyish silky look; is remarkable for its disagreeable though somewhat aromatic odour, and for its intense bitterness, whence its name has passed into a proverb. Its properties are imparted to water and spirit. According to Braconnot, 100 parts yield 1·5 *volatile oil* $C_{10}H_{16}O$, isomeric with camphor, of a dark-green colour, upon which the odour depends; 30 of bitter extract, 2·5 very bitter resin, and 5 green resin. The plant yields a large quantity of ash, which is chiefly carbonate of potash, and has been long called *salt of wormwood.* The bitter extract contains a peculiar neutral principle, called *absinthin*, $C_{16}H_{22}O_5$. Dr Luck obtained it by shaking æther with a strong alcoholic solution of the plant. The æther is distilled off, and resin separated by treating with a dilute ammoniacal solution. It is the essential bitter constituent of the plant.

Action. Uses.—An aromatic bitter tonic. It is taken to a large extent in the liqueur called "absinthe," of which elecampane is also a constituent. As its popular name implies, it has been used as an anthelmintic from time immemorial. The effect of large doses of the volatile oil appears to be identical with that produced by camphor; see *Lancet*, 1862, where Mr W. Smith relates a case in which a man recovered after swallowing ½ ounce of the oil.

Dose.—Of the powder, 20 to 60 grains; of the infusion (½ ounce to 10 ounces of water), 1 to 2 ounces.

The common tansy, *Tanacetum vulgare*, is an indigenous plant with a strong wormwood odour and taste; it has long been used as a tonic and anthelmintic, but is now superseded by remedies supposed to be more active.

LACTUCA VIROSA, *Linn.* The Strong-scented Lettuce.

This is supposed to be the *θρίδαξ ἀγρία* of Dioscorides, though *L. scariola*, Linn., is adduced by Dr Sibthorp as the plant. This has glaucous vertical leaves, but the same properties as *L. virosa.*

Characters.—The wild lettuce is a biennial, and abounds in acrid milky juice. *Root* tap-shaped. *Stem* round and erect, slender, glaucous, 2–4 feet high, a little prickly below, panicled above. *Leaves* horizontal, with a prickly keel, otherwise nearly smooth, finely toothed; radicle ones obovate, undivided, those of the stem smaller, often lobed, auricled, and semi-amplexicaul. *Flower-heads* numerous, panicled, with many small, heart-shaped, pointed bracts. *Flowers* light-yellow. *Achenia* striated, beak white, equalling in length the black fruit.—Dry banks and borders of fields throughout Europe.—*Eng. Bot.* t. 1956. Flowers about August.

This plant, distinguished by its rank smell and the blood-red spots on its stem, is preferred to the garden lettuce (*L. sativa*) as a source of lactucarium. Sir R. Christison states, from information communicated to him by Mr Duncan of Edinburgh, that it yields a much larger quantity and a superior quality of lactucarium, especially before the middle period of inflorescence; and Schutz has found in

Germany that a single plant of *L. sativa* yielded only 18 grains, while one of *L. virosa* produced no less than 56 grains of lactucarium.

The leaves of both species, when young, contain a pellucid pleasant-tasted juice, containing mucilage and sugar; but when the flowering stem begins to appear, the juice becomes milky, bitter, and of a strong odour, resembling that of opium. These characteristics increase until the flowers have blown. If slices of this stem be cut off, or incisions made into its cortical portion, the milky juice exudes, and on drying becomes of a brownish colour, forming the so-called *lettuce opium*, *lactucarium*, or *thridace.* Dr Coxe of Philadelphia, and subsequently Dr Duncan, sen., of Edinburgh, were the first to direct attention to the exudation. Dr Coxe was no doubt led to do so by the well known experience that bitter lettuce induces somnolency. The bitter milky juice is contained in the proper laticiferous vessels of the leaves and bark.

1. **Lactuca**, *P.B.* *Lettuce.*

The flowering herb of *Lactuca virosa.*

2. **Lactucarium.** *Dried Lettuce Juice.*

According to Hanbury and Flückiger, this substance is chiefly collected at Zell on the Moselle. It is there obtained as follows:—The stem is cut off about a foot from the top just before flowering time, after which a transverse slice is removed daily until September. The pure white juice, which readily becomes brown, is removed by the finger into a cup, in which it soon hardens.

Characters and Constituents.—In irregular roundish or angular pieces, of a hazel-brown colour externally, lighter coloured or even cream-coloured when recent internally, of a tough waxy consistence, a heavy odour strongly resembling opium, and a bitter taste. French lactucarium is formed into circular cakes, 1½ inch in diameter. Lactucarium yields to cold alcohol and to boiling water about 0·3 per cent. of *lactucin*, $C_{11}H_{12}O_3,H_2O$, and contains besides, a small quantity of *lactucopicrin*, $C_{44}H_{64}O_{21}$, *lactucic acid*, and about 58 per cent. of *lactucerin*, $C_{16}H_{26}O$. Lactucin appears to be the essential bitter of lettuce; it crystallises in pearly scales, which are soluble in hot water, alcohol, and acetic acid, but insoluble in æther. The aqueous solution reduces an alkaline solution of cupric oxyde. Alkalies deprive it of its bitterness. Lactucopicrin is an amorphous body, very bitter, and soluble in water and alcohol; it is probably a derivative of lactucin. Lactucic acid forms a yellow crystalline mass. Lactucerin, the largest constituent of lettuce, has been compared with euphorbon (see p. 438) by Flückiger. It is obtained by the action of boiling alcohol, from which it is deposited in colourless needles on cooling and concentration. It is an odourless, tastleless, neutral substance, which fuses at 365°; is insoluble in water, but soluble in æther, benzol, and both the fixed and volatile oils.

Besides the above constituents, lactucarium contains resin, albumen, gum, sugar, mannite, asparagin, succinic and other organic acids, and about 9 per cent. of inorganic matter, composed of the potassium, calcium, and magnesian salts of nitric and phosphoric acids.

Action and Uses.—Lactucarium, like opium, is liable to considerable variation in soporific action. The drug is not certain in its action, but the best kinds have a mild but decided hypnotic effect. It is to be observed that the constituents are very insoluble in aqueous fluids of the temperature of the body, and it is therefore to be expected that the action of the drug would be much more manifest if it were given in a minute state of subdivision, by mixing it with such a salt as sulphate of potash, or by forming an acetous solution. It may be used where opium is objectionable as a mild hypnotic.

Dose.—2 to 10 grains.

3. **Extractum Lactucæ,** *P.B. Extract of Lettuce.*

Prepared from the juice of the flowering herb *Lactuca virosa* in the manner described for extract of henbane.

This is lactucarium diluted with albumin, chlorophyll, and sugar, and probably deteriorated by prolonged exposure to heat.

Dose.—5 to 20 grains.

TARAXACUM DENS-LEONIS, *Dec.* Dandelion.

This common indigenous plant does not appear to have been used in medicine more than five or six centuries. It is doubtful whether the name *Taraxacum* is derived from the Grecians or Arabs. Rhazis and Avicenna speak of *Tarakhshagūn* as a species of wild endive (*H. and F. Pharmacograph.* p. 351).

Characters.—*Root* spindle-shaped, milky-juiced, smooth and dark-brown externally, white within, easily broken. *Leaves* numerous, radical, runcinate, glabrous, of a bright shining green. *Scapes* 1 or more, erect, brittle, with a single head of flowers, which expand in the morning, and are of a golden-yellow colour. *Involucre* double, external scales spreading or reflexed, internal ones in one row, erect, without callous tips. *Receptacle* naked. *Achenium* oblong, striated, muricate at the apex, terminating in a long beak. *Pappus* hairy, in many rows, radiating so as to a form a light globe. Fields and waste places throughout Europe, and extending even to the Himalayas. —*Eng. Bot.* t. 539; *Woodv. Med. Bot.* pl. 3 (*Leontodon Taraxacum*).

The leaves when young are, like those of endive, blanched and used as a salad in some parts of Europe: their properties necessarily vary at different periods of growth. Like that of the lettuce and some other cichoraceous plants, the juice of the taraxacum becomes milky at the time of flowering, and remains so during the ripening of the fruit, and it is at this time that the juice of the root is most milky and bitter.

1. **Taraxaci radix,** *P.B. Dandelion Root.*

The fresh and dried roots of the plant, gathered between September and February from meadows and pastures in Britain.

Characters and Constituents.—Tap-shaped roots, smooth and dark-brown externally, white within, and easily broken, and exuding an inodorous, bitter, milky juice, which becomes pale-brown by exposure. Not wrinkled nor pale coloured externally; juice not watery; any adherent leaves runcinate and quite smooth (thus distinguished from the root of the common hawkbit, *Leontodon hispidus*, Linn., or *Apargia hispida*, Willd.).

The milky juice acquires on exposure an acid reaction, and deposits masses of what Kromayer has called *leontodonium;* and he has separated from it an *acrid resin*, *taraxacin*, a colourless, amorphous, very bitter substance (Polex obtained this, or a closely allied body in the form of warty crystals, by boiling the milky juice with water, and allowing the concentrated decoction to evaporate) and *taraxacerin*, $C_8H_{16}O$, which resembles lactucerin. According to Messrs T. and H. Smith, the juice of the root develops a large quantity of mannite during a short exposure to the air. The dried root contains about 24 per cent. of inulin, and about 19 per cent. of lævulose (see p. 320). In the plant the former is convertible into the latter, for when the sugar is most abundant the inulin dwindles to less than 2 per cent. Inulin sometimes separates as a glistening powder when the extract is dissolved in cold water. According to Marme, the leaves and stalks of the plant yield *inosite*, $C_6H_{12}O_6,2H_2O$, or muscle sugar.

Action and Uses.—Dandelion has acquired the rude but expressive name "piss-a-bed" among the country people of the west of England, and a vague notion exists in the medical mind that it is a mild tonic and cholagogue, inducing, or tending to induce, a laxative action of the bowels. I have prescribed it in the usual doses, and have sometimes taken a wineglassful of the carefully prepared juice, but I am unable to say that I have ever observed or experienced the effects above mentioned. It is wise, perhaps, to retain honest convictions respecting the capabilities of a few harmless plants, for these latter may sometimes serve the purpose of removing a mental impression in our patients for which there is no more reason than there is for the assumption of a special virtue in the remedy. Thus we stumble again on a principle as old as medicine itself, but which has been so grossly misapplied by homœopathists. The roasted root is sometimes used as a substitute for coffee. It is sometimes mixed with the latter.

2. **Succus Taraxaci**, *P.B.* *Dandelion Juice.*

Preparation.—Bruise the *fresh root* in a stone mortar, press out the juice, and to every 3 measures add 1 of *rectified spirit.* Set aside for seven days, and filter. Keep in a cool place.

It is dark sherry-coloured, and of a pleasant bitterish taste.

Dose.—From 2 drachms to a wineglassful.

3. **Extractum Taraxaci**, *P.B.* *Extract of Dandelion.*

Preparation.—Crush the *fresh root*, press out the juice, and allow it to deposit; heat the clear liquor to 212° for ten minutes; then strain, and evaporate by a water bath at a temperature not exceeding 160°, until the extract has a suitable consistence for forming pills.

Dose.—5 to 30 grains. By extending the surface it increases the action of more powerful remedies, such as scammony, podophyllin, &c.

4. **Decoctum Taraxaci**, *P.B.* *Decoction of Dandelion.*

Prepared by boiling 1 ounce of the *dried root*, sliced and bruised, in 1 pint of water for ten minutes, then straining and washing the root so as to obtain 1 pint of the decoction.

Dose.—2 to 4 fluid ounces.

Cichorium Intybus, or wild chicory, which is indigenous in waste places all over Europe, is extensively cultivated on account of its root, which is much used as a substitute for, and as an addition to, coffee. The medical properties of the plant are considered to be nearly the same as those of taraxacum. It is used to adulterate coffee, and is itself often much adulterated. (See *P. J.* vol. iv. p. 119, Hassall, &c.)

VALERIANACEÆ, *Dec.* The Valerian Family.

These plants are distinguished from Compositæ by distinct stamens, a tricarpellary fruit, and a looser inflorescence, which is rarely capitate.

VALERIANA OFFICINALIS, *Linn.* Common Valerian.

Some of the Valerians have been used in medicine from the earliest times. Dioscorides describes three kinds of Nard or Valerian besides the Φου. The spikenard of the ancients, *Nardostachys Jotamansi* (*Him. Bot.* t. 45), a product of the Himalayas, is still highly esteemed in the East. *Valeriana celtica* and *Saliunca* are even imported by the Red Sea from Austria for perfuming their baths. (See *Illustr. Himal. Bot.* p. 242.) *V. Dioscoridis* is supposed to be the Φου or *Fu* of that author, and the officinal or wild Valerian was no doubt early introduced as a substitute for it.

Characters.—*Root* perennial, tuberous. *Stems* 2 to 4 feet high, smooth, furrowed. *Leaves* all pinnate, or pinnately cut; leaflets lanceolate dentate, in 7 to 10 pairs, terminal one very little, if at all, larger than the others. *Inflorescence* corymbose, becoming at length somewhat panicled. *Bracts* ovate-lanceolate. *Calyx-limb* involute during flowering, then unrolled into a deciduous pappus, consisting of many plumose hairs. *Corolla* roseate; tube funnel-shaped, gibbous at the base; limb 5 lobed. *Stamens* 3. *Fruit* smooth, compressed, 1-celled, 1-seeded, crowned by the limb of the calyx expanded into a feathery pappus. Ditches and damp places throughout Europe.—*Esenb. and Eberm.* t. 254; *Woodv. Med. Bot.* pl. 96.

The wild plant having proved insufficient for the demand of the drug market, the plant is now cultivated in the villages about Chesterfield, in Derbyshire. The virtues reside in the root.

1. **Valerianæ Radix**, *P.B.* *Valerian Root.*

The dried root of the plant above described, from plants indigenous to, and also cultivated in Britain. Collected in autumn, wild plants being preferred.

Characters and Constituents.—A short yellowish-white or brown rhizome, with numerous dark-brown fibrous roots, about 2 or 3 inches long; of a bitter taste and penetrating odour, agreeable in the recent root, becoming fœtid by keeping; yielding from ½ to 2 per cent. of *volatile oil* containing about 5 per cent. of *valerianic acid*, $C_5H_{10}O_2$ (see 47), when distilled with water.

Oil of valerian also contains about 25 per cent. of *valerene* or *borneene*, C_5H_8, which resembles oil of turpentine; and 70 per cent. of oxygenated components, amongst which is valerianic acid, as above stated, *valerol*, $C_6H_{10}O$, and a camphor identical with *borneol*, or the camphor of Dryobalanops (which see). Valerol is a constituent of the volatile oil of hops. It separates at 32° into transparent prisms, which retain their form until heated to 68°. Exposed to the air it is slowly converted into valerianic acid; this is instantly effected by caustic potash; thus, $C_6H_{10}O + 3KHO + H_2O = K_2CO_3 + 3H_2 + KC_5H_9O_2$, carbonate and valerianate of potash being formed and hydrogen eliminated.

Besides the above constituents, the root contains about 6 per cent. of resin, 12·5 of resinous extractive, 9·4 of watery extract, a little sugar and malic acid. The sugar reduces cupric oxyde.

Action and Uses.—Valerian, as a whole, is a stimulant, antispasmodic, and nervine tonic. Valerianic acid in large doses (two drachms or more) appears to have the same action as so much acetic acid, causing gastric irritation, nausea, and colicky pains, followed by slight exhilaration. As an antispasmodic it relieves the borborygma which so often attends the hysterical attack. For this disease, and its allies chorea and epilepsy, it has been largely prescribed, but with very variable, and, in the main, unsatisfactory results.

Dose.—Of the powder, 20 to 60 grains.

2. **Infusum Valerianæ**, *P.B.* *Infusion of Valerian.*

Prepared by infusing 120 grains of the bruised root with 10 fluid ounces of boiling water in a covered vessel for an hour, and straining.

It contains the extractive matter, a little volatile oil, and some valerianate of potash.

Dose.—1 to 2 fluid ounces.

3. **Tinctura Valerianæ**, *P.B.* *Tincture of Valerian.*

Prepared by exhausting 2½ ounces of the *root in coarse powder* with 1 pint of *proof spirit* in the manner prescribed for Tinctura aconiti, and obtaining 1 pint of the tincture.

Dose.—1 to 2 fluid drachms.

4. **Tinctura Valerianæ ammoniata**, *P.B.* *Ammoniated Tincture of Valerian.*

Preparation.—Macerate 2½ ounces of the *root in coarse powder*, with 1 pint of *aromatic spirit of ammonia* for seven days, with occasional agitation, then strain, press, filter, and add sufficient aromatic spirit of ammonia to make 1 pint of the tincture.

The whole of the essential constituents, including the resin, are contained in this preparation, and the presence of free ammonia increases the stimulant action of the valerian.

Dose.—½ to 1 fluid drachm.

CINCHONACEÆ, *Lind.* The Cinchona and Coffee Family.

The order is very closely allied to the Rubiaceæ. These latter are distinguished by truly whorled leaves, to which the interpetiolary stipules of

Cinchonaceæ furnish only an approximation. The Caprifoliaceæ are distinguished by the absence of stipules. The order is well illustrated by the following genera.

COFFEA ARABICA, *Linn.* The Coffee.

This is the *Quhwa* of the Coffeæ tribe of the Arabs. It is a native of Arabia and Abyssinia. From the former it has been introduced into various tropical countries, where it is largely cultivated.

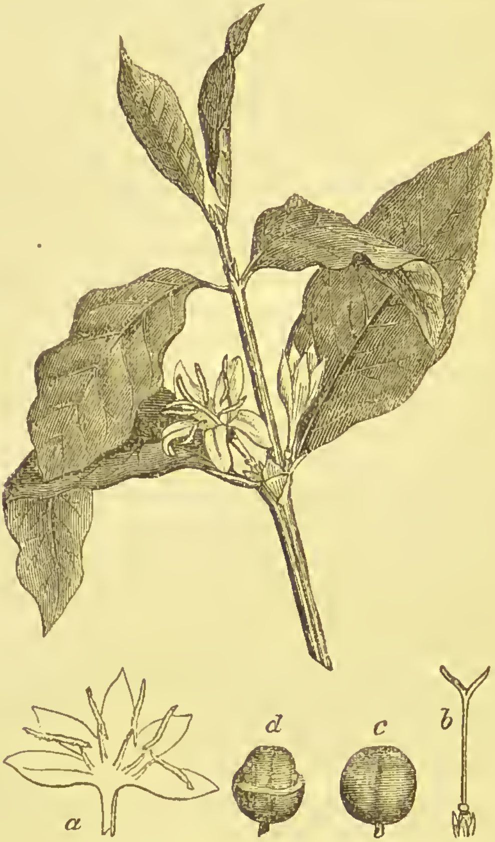

Fig. 88.—*Coffea Arabica.* *a*, corolla and stamens; *b*, style and stigmas; *c*, berry; *d*, berry with the two seeds exposed.

Characters.—It is a handsome evergreen *shrub*, 15 to 20 feet high. *Leaves* oblong-obovate, acuminate, shining. *Flowers* white, in axillary clusters. *Calyx* superior, 5-toothed. *Corolla* tubular, with a 5-parted spreading limb. *Stamens* 5. *Ovary* inferior, 2-celled, style bifid. *Fruit* an oval succulent, blackish-red, 2-seeded berry. *Seeds* plano-convex, with a longitudinal groove on the flat side, composed of horny and oily albumin. *Embryo* minute at one end of the albumin, the radicle corresponding to the micropyle, cotyledons cordate.—*Woodv. Med. Bot.* pl. 70.

The raw coffee berry is tough and hard, and almost tasteless and inodorous. It is roasted until it is friable. The characteristic bitter aromatic taste and fragrant odour are developed during the process. According to Payen, the roasted seeds contain from 10 to 13 per cent. of fixed oil; 0·002 per cent. of aromatic oil; 0·8 of caffein; 5 of caffeic acid; 13 of albuminous matter; 15 of gum, sugar, and vegetable acid; 34 per cent. of ligneous tissue; and about 7 of saline matters. Both the essential oil and the bitter flavour are developed from matter which is soluble in water. Caffeic acid is an astringent acid, closely allied to quinic, and when heated with peroxyde of manganese and sulphuric acid, it is decomposed with the formation of quinone (see p. 560) and formic acid.

Action and Uses.—Those of tea, the essential constituent being caffein (see Thea). Owing to the large quantity of fixed oil, coffee is not so easily digested as tea. It is a stimulant tonic and astringent, and these qualities render it very suitable in poisoning by the alkaloids. It has been recommeneed in spasmodic asthma; but I have known it excite dyspnœa or sneezing invariably in some persons, and especially those who inherit an asthmatic tendency. In some other persons it causes insomnia.

Dose.—In poisoning by the alkaloids and in spasmodic asthma, a strong infusion or decoction should be given freely.

CEPHAËLIS IPECACUANHA, *A. Richard.* Ipecacuanha.

Ipecacuanha is a name conferred by the natives of South America on a variety of emetic roots. Piso and Macgraaf (*Nat. Hist. Brazil,* 1648, pp. 17 and 101) were the first to distinguish that of the plant under consideration. Helvetius introduced it to Europe as a remedy for dysentery about the year 1686, but the plant

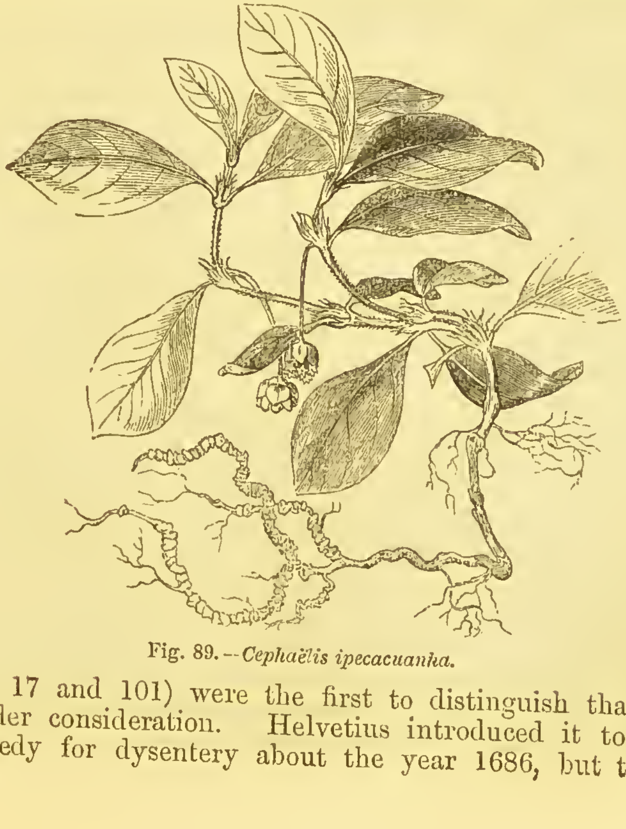

Fig. 89.—*Cephaëlis ipecacuanha.*

remained unknown until the beginning of the present century, when it was figured and described by Gomez (*Memoria sobre ipecacuanha fusca du Bresil*, 1801).

Ipecacuanha is a native of shady places in the forests of Brazil, from the province of Rio Janeiro to that of Pernambuco. It was found also in forests near Villa Mena by Weddell.

Characters.—Root perennial, simple, flexuose, or with a few diverging branches, a few inches in length, about the thickness of a quill, knotty, with transverse rings; when fresh, of a pale brown colour externally. *Stem* suffruticose, ascending, often rooting near the ground, at length erect, somewhat pubescent towards the apex. *Leaves* from 4 to 6 or 8 on a stem, opposite, oblong, obovate, acute, roughish above, finely pubescent beneath. *Stipules* erect, 4–6 cleft. *Peduncles* solitary, axillary, downy, erect when in flower, drooping when in fruit. *Flowers* collected into heads, and enclosed by a large 1-leafed involucre, which is deeply 4 to 6 cleft. *Segments* obovate. *Bracts* one to each flower, obovate, oblong. *Calyx* minute, with 5 blunt short teeth. *Corolla* white, funnel-shaped; tube downy on the outside and at the orifice; limb with 5 ovate reflexed segments. *Stamens* 5, projecting a little beyond the corolla. *Ovary* surmounted by a fleshy disk. *Stigma* bifid. *Berry* about the size of a coffee seed, dark violet, crowned by the remains of the calyx, 2-celled, 2-seeded, with a longitudinal fleshy dissepiment. *Seed* plano-convex, furrowed on the flat side. Flowers from November to March, and ripens fruit in May.—*Linn. Trans.* vi. t. 11 (*where it is described as a species of Callicocca*); *Martius, Spec. Mat. Med. Bras.* 4 t. 1; *St Hilaire, Pl. Us. de Brazil*, pl. 1; *Nees and Eberm.* 258; *Steph. and Church*, pl. 62.

1. Ipecacuanha, *P.B. Ipecacuanha.*

The dried root of the plant above described, imported from Brazil.

Characters and Constituents.—In pieces 3 or 4 inches long, about the size of a small quill, contorted and irregularly annulated; of a brown colour of various shades. It consists of two parts, the cortical or active portion which is brittle, and of an almost inert slender tough woody central cord. Powder pale brown, with a faint nauseous, and a somewhat acrid and bitter taste. The bark forms about 75 to 80 per cent. of the root. It yields about 30 per cent. of starch, a little resin, fat, albumin, and sugar and gum, and a large proportion of pectin. The essential constituent is *emetia*, $C_{30}H_{44}N_2O_8$ (Lefort), which is combined with *ipecacuanhic acid*, and a trace of volatile oil.

Emetia exists in the root in the proportion of about 1 per cent.

Ipecacuanhic (cephaëlic) acid is an amorphous, reddish-brown, bitter, and very deliquescent substance. It is a glucoside, and is closely related to caffetannic and kinic acids; it is soluble in water, and develops a green colour with perchloride of iron.

2. Emetia. *Emetina or Emetine*, $C_{20}H_{30}N_2O_5$.

This alkaloid may be prepared by exhausting the powdered root with alcohol, recovering the alcohol by distillation, adding to the resulting fluid-extract an excess of caustic potash, and shaking with chloroform (Lefort). The formula above given is that of Reich. It will be observed that it is that of quinia + $3H_2O$. Emetia when pure is amorphous, colourless, inodorous, bitter, and acrid. Its basic properties are feeble, but Reich has obtained crystals of the hydrochlorate; the nitrate is a soft resin-like mass, remarkable amongst nitrates for its insolubility, requiring no less than 100 parts of water for solution. Emetia melts at 158°. It is freely soluble in alcohol, chloroform, and dilute acids; it is only sparingly soluble in water or æther. Aqueous solutions of the alkaloid or its salts give copious precipitates with tannic acid and nitrate of potash, both the tannate and nitrate being very insoluble. A solution in acidulated water exhibits a decided blue fluorescence (Draggendorf).

Action and Uses.—My friend Dr Dyce Duckworth has carefully studied the action of this drug. The following are, in brief, his conclusions (*St Bartholomew's Hosp. Reports*, vols. v. and vii.):—Locally applied, ipecacuanha is an irritant; a little of the powdered root, or a particle of the alkaloid, placed on the conjunctiva or underneath the prepuce, produces in the one case great pain and lachrymation, followed by a more or less severe attack of ophthalmia, with purulent discharge; and in the other case inflammation, which may even pass into ulceration and sympathetic irritation of the inguinal glands. Inunction of the alkaloid into the unbroken skin produces a pustular eruption. The ingestion and subcutaneous injection of emetia produce the same effects, viz., vomiting; or if the vagi be divided, retching, attended by great muscular relaxation, failure of the heart's action, with loss of temperature; and if the dose be an excessive one, collapse preceded sometimes by purging and acceleration of the breathing, in the course of twenty-four or thirty-six hours. During the action of the drug the urine commonly becomes albuminous. After death dark blood is found on both sides of the heart, the lungs are severely congested, and the bronchial and gastro-intestinal mucous membrane are inflamed. The emetia is in part at least eliminated by the kidneys, tannic acid producing a precipitate in the urine voided after its ingestion.

It appears from these observations that the operation of tartar emetic and emetia are in the main identical; emetia, however, appears to exercise a more direct and rapid action on the heart. Both drugs pass into the blood, and are then thrown out upon the surface, exciting them to increased secretion, and in the act of elimination producing local irritation, which, in the case of the more delicate mucous surface, may pass into inflammation. Thus the more prominent effects of ipecacuanha are due to an eliminative action, the nervous system meanwhile suffering great depression.

In small medicinal doses ipecacuanha is sudorific and expectorant; in larger, it is nauseant and depressent; and in full doses emetic. The emetic action is most readily induced when the stomach is empty of food. Owing to a direct stimulant action on the intestinal mucous membrane, ipecacuanha has always maintained a reputation in the treatment of chronic dysentery. Emetic doses, by a counter irritant action, are also very beneficial in the acute form. In atonic dyspepsia, and in the vomiting of pregnancy, small doses of ipecacuanha are often serviceable. In the treatment of catarrh and febrile affections, especially when associated with or dependent upon bronchitis or pneumonia, this drug is an appropriate remedy, not because it is liable to increase the hyperæmia of the lungs and skin—this having already attained its maximum—but that it promotes exudation from surfaces which are dry and irritable or painful from arrest of natural secretion. In croup the drug has a double action, affecting the inflamed membrane in the manner just indicated, and when given in emetic doses facilitating, by the expulsive efforts which it induces, the separation of the membranous exudation. The emetic action of ipecacuanha is not so depressent as that of tartar emetic, but it is not so well adapted for the evacuation of the stomach in cases of poisoning as a purely irritant emetic, such as mustard or sulphate of zinc. If it should be employed in these cases, it is best to give it by subcutaneous injection.

Dose.—Of ipecacuanha powder as a diaphoretic and expectorant, 1 to 3 grains; as a nauseant and depressent, 3 to 5 grains; as an emetic, 10 to 20 grains.

Dr Duckworth found that the $\frac{1}{20}$th of a grain of emetia uniformly produced free vomiting in adults within fifteen minutes of its injection into the subcutaneous tissue.

Pharmaceutical Uses.—A constituent of Pilula conii composita, and of the following:—

3. **Acetum Ipecacuanhæ.** *Vinegar of Ipecacuanha.*

Of all the solvents of emetia acetic acid is perhaps the best, and one that retains it unchanged for a longer time than dilute alcohol. Dr Dyce Duckworth has advocated the use of acetous preparations of ipecacuanha (*Pharm. Journ.* March 1872), and has shown their superiority over the vinum. This latter cannot be called either a very efficient or certain preparation; for it is a matter of common experience that the ordinary doses fail to induce emesis, and that a patient will sometimes take an ounce or more before it is effected. No doubt much of this uncertainty results from want of care in the perservation of the root, for Mr D. Hanbury states that "it very often arrives in England much deteriorated by damp," and that he "has the authority of an experienced druggist for saying, that at least three packages out of every four offered in the London drug sales have either been damaged by sea water or by damp during the transit" (*Pharmacographia*, p. 336). This is a serious matter, and implies the want of a drug inspector, who would have authority to secure the delivery in this country of ipecacuanha root and other vegetable productions in well-secured tin canisters. But however this may be, there is certainly need of a stronger fluid preparation of ipecacuanha than the vinum, and this need may readily be supplied by adopting the formula for Acetum scillæ.

Preparation.—Macerate 2½ ounces of *ipecacuanha* in coarse powder in 1 pint of *dilute acetic acid* for seven days, with occasional agitation; then strain, and wash the residue with sufficient dilute acetic acid to make the product measure 1 pint.

This is about thrice the strength of the Vinum ipecacuanhæ.

Dose.—5 to 10 minims as a diaphoretic and expectorant; 10 to 20 minims as a nauseant; and 60 to 120 minims as an emetic.

4. **Oxymel Ipecacuanhæ.** *Oxymel of Ipecacuanha.*

Prepared in the manner directed and in the same proportions as Oxymel scillæ, using the Acetum ipecacuanhæ instead of Acetum scillæ.

Dose.—15 to 30 minims as a diaphoretic and expectorant; $\frac{1}{2}$ to 1 fluid drachm as a nauseant.

5. **Vinum Ipecacuanhæ,** *P.B.* *Ipecacuanha Wine.*

Preparation.—Macerate 1 ounce of *ipecacuanha in coarse powder* in 1 pint of *sherry* for seven days, with occasional agitation; strain, press, and filter; then add sufficient sherry to make one pint.

Dose.—5 to 40 minims as an expectorant; 3 to 6 fluid drachms as an emetic.

6. **Pulvis Ipecacuanhæ compositus,** *P.B.* (See preparations of Opium.)

Contains 1 grain of ipecacuanha in 10.

7. **Trochisci Ipecacuanhæ,** *P.B.* *Ipecacuanha Lozenges.*

Preparation.—Mix together 180 grains of *ipecacuanha*, 25 ounces of *refined sugar*, and 1 ounce of *gum acacia*, all in fine powder, and add 2 fluid ounces of *mucilage of gum acacia* and 1 ounce of *water*, or a sufficiency to form a proper mass. Divide into 720 lozenges, and dry these in a hot-air chamber with a moderate heat. Each lozenge contains $\frac{1}{4}$ grain of ipecacuanha.

Dose.—1 to 3 lozenges.

8. **Pilula Ipecacuanhæ cum Scilla,** *P.B.* *Ipecacuanha and Squill Pill.*

Since the proportion of ipecacuanha to squill in this preparation is as $\frac{3}{10}$ to 1, it would be more proper to call it P. scillæ cum ipecacuanha.

Preparation.—Mix together 3 ounces of *compound powder of ipecacuanha* and 1 ounce each of *powdered squill* and *powdered ammoniacum;* add sufficient *treacle*, and beat into an uniform mass.

Action and Use.—A very useful sedative expectorant, and diaphoretic.

Dose.—5 to 10 grains.

Other Cinchonaceous Emetics, or *False Ipecacuanhas.*—Ipecacuanha is not liable to adulteration, nor is there any known root that could be mistaken for it by any one of ordinary powers of observation. Some confusion may, however, arise from the fact that ipecacuanha and its equivalent *Poaya* are applied as generic names for other emetic roots, some of which do not even belong to the Cinchonaceæ (see Ionidium Ipecacuanha).

The roots of the following plants are sometimes met with :—

1. **Psychotria emetica**, *Winks*, yields *Striated, Black* or *Peruvian Ipecacuanha.*—This is a native of Peru and New Granada. The roots are thicker than those of ipecacuanha; they are destitute of annulations, but present at long intervals constrictions, deep indentations or fractures in the bark, extending to the central woody cord. The surface is marked with fine longitudinal furrows, the cortex is never brittle, and a fresh section of the soft tissue exhibits a dull violet hue. The essential constituent is emetia.

2. **Richardsonia scabra**, *Decand.*—This is a native of Brazil. The root is knotted, undulating, and of an iron-grey colour. Like ipecacuanha and the foregoing, it is composed of a thick cortex and a fine central woody cord, and the cortex is sometimes broken away as in ipecacuanha, but it is never annulated. It is white and farinaceous within.

A small striated Ipecacuanha has been described; it differs from the foregoing in being in smaller pieces, tapering to either end. The cortex is also very brittle. The woody cord presents numerous pores. Professor Planchon regards it as the produce of a species of *Richardsonia.*

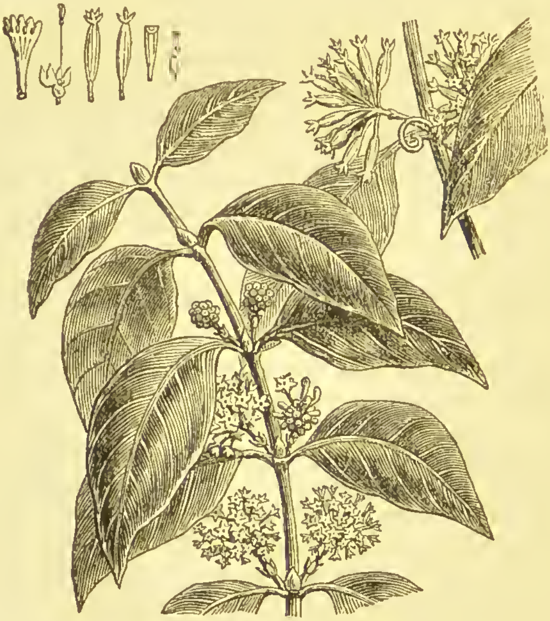

Fig. 90.—*Uncaria Gambier.*

UNCARIA GAMBIER, *Roxb.* The Gambier Shrub.

This climbing shrub, the source of the catechu of the Pharmacopœia, is a native of the East Indian Archipelago and Ceylon.

Characters.—Stem shrubby, with rough brown bark, climbing and supporting itself by the flower-stalks, which are developed into strong hooks.

Branches crowded, round, smooth; branchlets opposite, spreading. *Leaves* opposite; stalked, ovate, wavy, marked below with transverse parallel veins. *Stipules* 2, caducous. *Peduncles* axillary, solitary, pointed, forming a hooked spine after the flowers have fallen. *Bracts* 4, small, ovate, caducous. *Flowers* in loose capitula, green and pink. *Calyx* adherent, urceolate, 5-cleft. *Corolla* hypocrateriform, 5-cleft. *Stamens* 5, with very short filaments. *Capsule* stalked, oblong, crowned with the calyx, tapering to a point below; 2-celled, 2-valved, valves adhering at the apex, splitting at the sides. *Seeds* numerous, oblong, very small, winged.

Habitat.—Malacca and Sumatra.—*Trans. Linn. Soc.*, vol. ix. pl. 22 (*Nauclea Gambir*).

The whole of the plant abounds in astringency; the catechu is, however, derived from the leaves. The plant is very extensively cultivated by the Chinese at Singapore and the islands south-east of it. Pepper is generally cultivated in the same plantations. At Rhio, in the island of Bintang, there are, according to Bennett, 60,000 plantations. The leaves are boiled in water until their astringency is all extracted; this decoction is then inspissated, and cut into square pieces to dry.

1. **Catechu pallidum**, *P.B.* *Pale Catechu.*

An extract from the leaves and young shoots of the plant above described, prepared at Singapore and other places in the Eastern Archipelago.

Characters and Constituents.—In cubes, or masses formed of coherent cubes, the former about an inch square, externally brown, internally ochrey-yellow, or pale dull red, breaking easily with a dull earthy fracture. Under the microscope, it is seen to consist of minute acicular crystals. Taste bitter, very astringent and mucilaginous, succeeded by slight sweetness. Entirely soluble in boiling water. The decoction, when cool, is not rendered blue by iodine (absence of starch).

Pale catechu agrees in composition with Pegu catechu or cutch (see Acacia). Cold water dissolves a considerable portion, *catechu-tannic acid;* the residue is *catechin* or *catechuic acid*, $C_{13}H_{12}O_5$. If it be dissolved in hot water, it is deposited, on cooling, in long acicular crystals. An aqueous solution of catechin does not precipitate solutions of gelatine and the vegetable alkaloids, but after boiling some time it possesses this property, owing to its conversion into catechu-tannic acid. Rochleder has shown that anhydrous catechin is a compound of phloroglucin, $C_6H_6O_3$, and æschylic alcohol, $C_7H_8O_3$. Acids convert it into a brown amorphous substance, catechuretin, by the removal of an atom of water.

Action and Uses.—Those of tannic acid (see p. 420).

Dose.—10 to 30 grains.

2. **Infusum Catechu**, *P.B.* *Infusion of Catechu.*

Prepared by infusing 160 grains of *pale catechu* in coarse powder, and 30 grains of *cinnamon bark* bruised, in 10 ounces of *boiling water*, for half an hour, and straining.

This is a solution of catechu-tannic acid chiefly, most of the catechin being deposited as the solution cools.

Dose.—1 to 4 fluid ounces in diarrhœa, dysentery, or as a vaginal injection in leucorrhœa.

3. **Tinctura Catechu**, *P.B.* *Tincture of Catechu.*

Preparation.—Macerate 2½ ounces of *pale catechu* in coarse powder, and 1 ounce of *cinnamon bark* bruised, with 1 pint of *proof spirit*, occasionally shaking, for seven days; strain, press, filter, and add proof spirit to make 1 pint of the tincture.

Dose.—½ to 2 fluid drachms, as an adjunct to Mistura cretæ, &c.

4. **Trochisci Catechu**, *P.B.* *Catechu Lozenges.*

Preparation.—Mix together 720 grains of *pale catechu*, 25 ounces of *refined sugar*, and 1 ounce of *gum acacia*, all in fine powder, then add 2 fluid ounces of *mucilage of gum acacia*, and sufficient water to form a proper mass. Divide into 720 lozenges, and dry these in a hot-air chamber with a moderate heat. Each lozenge contains 1 grain of catechu.

Dose.—1 to 6 lozenges for relaxed throat, or tendency to diarrhœa.

5. **Pulvis Catechu compositus**, *P.B.* *Compound Catechu Powder.*

A sifted mixture of 4 ounces of *pale catechu*, 2 ounces each of *kino* and *rhatany root*, and 1 ounce each of *cinnamon* and *nutmeg*, all in fine powder. An aromatic astringent in pyrosis and diarrhœa.

Dose.—20 to 40 grains.

CINCHONA, *Linn.* SPECIES VARIÆ. Cinchona Trees.

This genus is composed of about 36 known species, a third of which yield the cinchona barks of commerce.

Generic Characters.—Fine evergreen forest *trees*, with a white wood, simple entire *leaves*, and deciduous stipules. *Flowers* cymose-paniculate, white, flesh-coloured or purple, very fragrant. *Calyx* adherent, turbinate, limb 5-toothed, superior. *Corolla* hypocrateriform, tube roundish, limb expanded, 5-fid, lobes lanceolate, fringed at the margin, pubescent externally, valvate. *Stamens* 5, inserted into the tube of the corolla. *Capsule* ovate, oblong, or linear-lanceolate, crowned by the thickened limb of the calyx, 2-celled, many-seeded, dehiscing from the base upwards into the valves which are held together at the apex by the woody limb of the calyx. *Seeds* peltate, compressed, imbricated, surrounded by a membranous denticulated wing, albuminous. *Embryo* straight in the margin of the fleshy albumin, cotyledons ovate, radicle terete.

The cinchonas are confined exclusively to the Andes, and grow chiefly on the eastern face of the Cordilleras, where occurs the zone of forests, from about 3000 to 12,000 feet of elevation above the sea. In some places they are found on the western face, where this is covered by forests. The cinchonas themselves seldom form an entire forest, but rather groups (called *manchas*). Frequently they grow separately, sometimes in exposed situations, where even the arborescent species do not grow beyond the size of shrubs. The characteristics of this forest are of a tropical nature. Palms seem to be found throughout, and in many parts form the principal feature. Along with these there are tree ferns, gigantic climbers, bamboos, plantains, Aroidaceæ, Cecropias, Melastomaceæ, an occasional oak, and Myrica, and other genera, as in the Lower and Southern Himalayas, as well as on the Neilgherries. There is always great moisture, and a mean temperature of about 62°.

The cinchona region forms a great but comparatively narrow arc of a circle which has its convexity towards the west, and of which the most western part is near its middle or about Loxa, where it approaches the sea. The northern extremity of the arc reaches nearly to Caraccas, about 10° of N. lat., while the southern extremity reaches to near Santa Cruz de la Sierra in Bolivia, about 19° S. lat.

The genus was named by Linnæus in compliment to the Countess of Chincon, wife of the then Viceroy of Peru, who was cured by, and who brought from thence to Europe in 1639 some of this celebrated and invaluable bark. The native names *quinquino* and *quina-quina* are, however, very similar to the scientific one. It is also called *cascarilla* in South America. The history of the discovery of Peruvian bark is obscure. The natives are supposed to have been unacquainted with its virtues, but the Indians of Malacatos knew them in 1739, and others before 1696. Its medicinal use was thought to have been discovered by the Jesuits, who chiefly made the bark known at an early period in Europe. The plant or plants yielding the bark were long entirely and are still in some measure unknown. The first published notice seems to be that of Dr Arrot in the *Philosophical Transactions* for 1737. In that year also La Condamine visited Loxa, and sent a memoir, *Sur la Quinquina*, in the following year to the Acad. Royale des Sciences. Since this time numerous observers have contributed to the history of the chinchonas, and the most valuable species have been introduced into India and other countries, where they are largely cultivated.

A few years after Dr Weddell's return to Europe, the Dutch Government directed its attention to the introduction of the cinchona trees into Java. The governor of Java sent Mr Hasskarl to Peru and Bolivia. After a residence of two and a half years he obtained 400 plants of the *C. Calisaya*, which were forwarded from the port of Islay to the island of Java, and arrived there in 1853. They were planted in the mountainous country near Bandong. Dr de Vry, the chemical inspector, reported in 1860 that the trees were in a flourishing condition (half a million or more were planted out), had grown to a height of 16½ feet, and produced thousands of fruits, the seeds of which had germinated. He had obtained bark which yielded 4 per cent. of alkaloids.

Though the Dutch were the first to succeed in the acclimatisation of the cinchona, the persevering efforts of the Government of British India have at last been rewarded with success, and plantations of these valuable trees are now flourishing on the Neilgherry hills and in the valleys of the Himalaya in British Sikkim. Mr Markham was sent from England in 1859 to procure the *C. Calisaya* and other species. He started from Arequipa in Peru on March 12, 1860.

After a toilsome journey, in which he failed to penetrate into Bolivia, he obtained upwards of 500 of the young calisaya trees on the eastern Cordilleras within the Peruvian frontier. These were taken to Southampton by the Isthmus of Panama; 73 were broken in the passage across the Andes to Islay; about half of the remainder perished in the long voyage. The rest were forwarded in glass cases by the overland route to India, but when they arrived they were all dead. Mr Markham was unable to obtain seeds from Bolivia, on account of the jealousy of the Government. He brought none from Peru, as at that season of the year they were not ripe. He left directions, however, with agents in Peru and Ecuador, that they should send seeds and plants to him in India. In the spring of 1861 living seeds and plants were received by Mr M'Ivor at the garden of Ootacamund. In August 1862, 100,000 healthy plants were rooted; in October 1863, 250,000. (See Markham's *Travels in Peru and India*, 1862, also *Pharm. Journ.* 1861–1863.) Many seedlings have been sent to India from the nursery at Kew. The plants growing on the Neilgherries are *C. Calisaya*, *C. officinalis*, *C. micrantha*, *C. nitida*, and *C. succirubra*. The last (red bark) was grown from seeds sent by Mr Spence from Chimborazo. It is being cultivated by Dr Anderson at Darjeeling in Sikkim in the Bengal Presidency, and cases of ague and fever have already been cured by its bark. *C. succirubra*, *Calisaya*, and *micrantha*, are being cultivated by Mr Thwaites with much success in Ceylon. 2·8 per cent. of the alkaloids have been obtained by De Vry from the bark of the *C. succirubra* cultivated in India. Mr Howard has reported 3·3 per cent. of alkaloids in specimens sent to him for analysis by the Secretary of State for India.

Since 1863 the cultivation of the cinchonas in India has been immensely extended, and already British India bids fair to compete, at no distant period, with Central and South America as a source of quinine. It has sent cinchona bark in rapidly increasing quantities to the London market since 1867.

The cultivation of cinchona has been successfully undertaken in Jamaica, under the auspices of Dr Daniell. A grant of young trees from the nursery at Kew has been recently made to the French Government, which is anxious to introduce the plant into Algeria.

The area over which the cultivation of cinchona is extended cannot possibly be too wide. The supply of a drug so important to Europe, and which to some parts of the world is a necessary of life, must not be suffered to depend upon a few forests in America, or be at the mercy of reckless cultivators or selfish governments.

The cinchona trees are greatly esteemed as the source of quinia, an alkaloid which is chiefly stored in the bark.

Collection of the Bark.—It is thus collected in Peru:—A region of forests previously unexplored is first examined by *practicos* or experienced *cascarilleros*, that is, Indian bark collectors. A *major domo* is then sent into the forest, who receives and examines the bark as it is brought in by the cascarilleros, having previously distributed provisions to them. The bark is peeled about the month of May, or at any time excepting during the rainy season. It is either cut from the trees as they stand, or the trees are felled a little above their roots. This is the preferable method, as suckers shoot up from their roots, and soon yield profitable bark. The periderm is removed by striking the trunk with a mallet. The bark is sometimes cleaned with a brush, and then taken off by uniform incisions in pieces about 15 or 18 inches long, and 4 or 5 inches wide. The thinnest pieces of bark from the branches or small trunks are simply exposed to the sun's rays, and soon assume the form of hollow cylinders, or that of the quilled cinchona. The bark from the large trunk, which is to constitute the flat (*tabla* or *plancha*) cinchona, undergoes a certain degree of pressure during the process of drying. The major domo rejects the bad specimens of bark and sews the remainder up in coarse canvas. When it reaches the depôts in towns an outer envelope of a fresh hide forms the packages, known by the name of *serons*, which usually contain only one kind of bark. The mode of cutting down the trees or stripping them of their bark is most wasteful; and but for the timely cultivation of the quinia, must soon have resulted in its extinction.

Structure of Cinchona Barks.—A few general observations on the structure of the bark of cinchona will be appropriate here. The epidermis is only found on the youngest bark before it has attained sufficient age for medicinal use; it is then replaced by the *corky* layer. In most species this cracks and is easily separable, but in some it is firmly attached to the internal layers. These are composed of the middle layer of the bark or *mesophlœum*, formed of parenchyma; and the innermost layer, *endophlœum* or liber. The middle layer disappears in some barks, which are thus wholly composed of liber. This is a means of distinguishing them. The liber is traversed by medullary rays, which project into the mesophlæum. It is therefore composed of woody fibres (prosenchyma) and soft parenchyma. The arrangement of the woody fibres, their colour, size, and shape, give a special character to the cinchona barks. As compared with other barks, the fibres of the liber are shorter and more loosely arranged, being for the most part separate or united into very short bundles. The fibres therefore are easily isolated; they are spindle-shaped, sub-quadrangular, rarely exceeding $\frac{1}{10}$ of an inch in length, usually straight, and are very brittle, the cavity of the cell of which each is composed being reduced by secondary deposits to a fine canaliculus. This short and loose fibrous structure is not found in other barks.

In some cinchona bark a system of laticiferous vessels is found between the liber and mesophlæum.

The parenchyma of the bark is laden with starch and oxalate of lime, or a soft brown deposit. According to Howard, they contain kinates of the cinchona alkaloids in the form of acicular crystals, separate or aggregated into minute rounded masses.

Composition of Cinchona Barks.—The essential properties of cinchona are due to the following alkaloids:—

Quinia (*Quinine*),	$C_{20}H_{24}N_2O_2$.
Quinidia (*Quinidine* or *Conquinine*),	$C_{20}H_{24}N_2O_2$.
Cinchonia (*Cinchonine*),	$C_{20}H_{24}N_2O$.
Cinchonida (*Cinchonidine*),	$C_{20}H_{24}N_2O$.
Quinamina (*Quinamine*),	$C_{20}H_{26}N_2O_2$.

Paricina, detected in the bark of *C. succirubra*, and *aricia*, *cinchovatia*, and *cusconia*, found in barks which contain only small proportions of the more active constituents mentioned above, are as yet imperfectly known.

1. Quinia or Quinine, $C_{20}H_{24}N_2O_2$, $3H_2O = 324 + 54$.

It may be obtained from the sulphate (see p. 565) by precipitation with ammonia. It crystallises from alcohol in silky prisms, having the composition above given. They become anhydrous at a low temperature, or even by exposure over a dish of sulphuric acid. Above 240° the alkaloid fuses into a resinoid mass, which may be distilled for the most part without decomposition. Anhydrous quinia is soluble in 350 parts of water, 21 of æther, and is more freely soluble in alcohol and chloroform. It is also soluble in both volatile and fixed oils. It yields crystallisable salts with acids; solutions of these in excess of acid pass into the amorphous resinoid condition (see Quinoidine) when exposed to direct sunlight. These solutions are intensely bitter—1 part in 100,000 possessing this quality—and yield precipitates with tincture of galls, gallic, tartaric, and oxalic acids, and with mercuric and argentic nitrates. When chlorine is passed through water in which quinia is suspended, the alkaloid is dissolved, and the solution exhibits a beautiful variation of colours, from pink to purple, and then to dark red. Ten volumes of a solution of quinia, or one of its salts mixed with one volume of chlorine water, develop a brilliant green colour on the addition of a drop of ammonia; and if the mixture contain more than the $\frac{1}{1000}$ part of quinia a green precipitate called *thalleioquin* or *dalleiochine* is formed. This test is available when the solution contains only 1 part of quinia in 5000. If bromine be used instead of chlorine, the test is said to succeed when the solution contains not more than the $\frac{1}{20000}$ part of quinia (*Pharm. Journ.* 1872, p. 901).

A *dilute* solution of quinia in excess of sulphuric acid exhibits a blue fluorescence, which is observable in a solution containing less than 1 part of the alkali in 200,000 of water.

Sulphate of quinia forms with iodine a beautiful crystalline compound, *iodo-sulphate of quinia* ($C_{20}H_{24}N_2O_2$, $I_2H_2SO_45HO_2$).

It is often accidentally formed when a solution of potassium iodide containing iodate is mixed with one of sulphate of quinia. It may be prepared by dissolving the sulphate in 10 parts of proof spirit containing 5 per cent. of sulphuric acid, and adding an alcoholic solution of iodine until a black precipitate is no longer formed. It is then collected on a filter, washed with a little alcohol, and then dissolved in boiling alcohol, and allowing it to crystallise. Or acid sulphate of quinia may be dissolved in concentrated acetic acid and tincture of iodine added drop by drop to the heated solution. The salt is deposited after a few hours in large rectangular plates of a brilliant green colour and metallic lustre by reflected light, and of an olive tint by transmitted light. In their optical qualities they resemble tourmaline.

Quinia forms with sulphuric acid a neutral, and an acid sulphate $C_{20}H_{24}N_2O_2H_2SO_4,7H_2O$.

For an account of the former, see p. 565.

2. **Quinidia**, $C_{20}H_{24}N_2O_2,2H_2O = 324 + 36$.

This base is isomeric with quinia. It may be extracted from quinoidine by means of æther. The ætherial solution deposits it in long rhombic efflorescent prisms. It becomes anhydrous when heated, and fuses at 320°. It requires 1500 parts of cold and 750 of boiling water for solution, and about 45 of cold and 11 of boiling alcohol, and about 30 parts of æther. It agrees with quinia in bitterness, fluorescence, and the production of a grass-green colour with chlorine and ammonia. Solution of iodide of potassium precipitates an insoluble hydriodate, by which means it may be separated from the other alkaloids of bark.

It forms with sulphuric acid a neutral and an acid sulphate, which are five times more soluble in chloroform and eight times more soluble in water than the sulphates of quinia (Hesse).

Sulphate of quinidia, $(C_{20}H_{24}N_2O_2)_2H_2SO_4,5H_2O$, resembles sulphate of quinia, and commercial quinia often contains a considerable quantity of it.

3. **Cinchonia**, $C_{20}H_{24}N_2O = 308$.

Contains an atom of oxygen less than quinia. It crystallises in large anhydrous, 4-sided prisms, which fuse at 329°, and may be sublimed unchanged in a current of hydrogen. It is soluble in 120 parts of alcohol and 400 of æther, and 2500 of cold and 1500 of boiling water. It is readily soluble in solutions of the alkalies and alkaline bicarbonates. Its salts are intensely bitter, and their solutions are precipitated by infusion of galls and solution of the gallates, oxalates, and tartrates. The hydriodate is readily soluble in water and alcohol. Cinchonia and its salts are not fluorescent in solution, and fail to develop a green colour with solution of chlorine or bromine and ammonia. Cinchonia forms with sulphuric acid a neutral and an acid sulphate.

The *normal sulphate of cinchonia* $(C_{20}H_{24}N_2O)_2H_2SO_4,H_2O = 714 + 36$, forms irregular prisms, becomes phosphorescent when gently heated, and melts like wax at 212°. When retained in this condition for a few hours in contact with a little excess of sulphuric acid, it is converted into sulphate of cinchonicia. Heated beyond this, it is converted into a ruby-red resinoid mass. The acid sulphate, $C_{20}H_{24}N_2O,H_2SO_43H_2O$, crystallises in bold rhombic octohedra, which are very soluble both in water and in alcohol. *Hydrochlorate of cinchonia* is also a very soluble salt, resembling sulphate of quinia in appearance.

4. **Cinchonidia,** $C_{20}H_{24}N_2O = 308$. Isomeric with cinchonia.

This alkaloid separates from alcohol in anhydrous rhomboidal prisms, which are hard and striated. They fuse at 500°, and above this are decomposed, evolving the odour of oil of bitter almonds. Cinchonidia is soluble in 76 parts of æther and 20 of alcohol. Solutions of the alkali or its salts neither exhibit fluorescence nor give the thalleioquin reaction with chlorine and ammonia. The sulphate, $(C_{20}H_{24}N_2O)_2H_2SO_4$, crystallises in tufts of silky needles; the hydrochlorate in large brilliant prisms, soluble in 27 parts of water. Phosphate of soda, nitrate of silver, and corrosive sublimate gives white precipitates with the salts of cinchonidia.

5. **Quinamina,** $C_{20}H_{26}N_2O_2 = 326$.

This alkaloid was discovered in the bark of *C. succirubra* by Hesse. It forms anhydrous crystals, which fuse at 340°; are soluble in 32 parts of æther and 100 parts of alcohol, and slightly in boiling water. Solutions of this base or of its salts do not exhibit either fluorescence or a green coloration on the addition of chlorine and ammonia. Retained in acid solution it is converted into the amorphous state, as occurs with the other alkaloids.

6. **Quinoidine,** or *The Uncrystallisable Alkaloids.*

The cinchonia alkaloids, when heated with excess of mineral acid, are partially converted into amorphous modifications—quinia into *quinicia*, cinchonia and cinchonidia into *cinchonicia*, &c. These varieties are always formed in the processes adopted for the separation of the alkaloids, just as treacle is produced in the separation of crystalline sugar. A mixture of them, obtained by precipitating with ammonia the brown mother-liquors from which the crystalline alkaloids have been separated, is employed as a cheap substitute for quinia, under the name *quinoidine* or *chinioidin.* When first introduced it was a dark-brown brittle substance, but both the alkaloid, or rather mixture of alkaloids, and its combinations with sulphuric and hydrochloric acid, are now obtained as nearly colourless powders.

The cinchona alkaloids are naturally combined with the following acids :—

1. *Quinic (kinic) acid,* $C_7H_{12}O_6$, which crystallises in large rhombic plates of a strong and purely acid taste; soluble in 2 parts of water, moderately so in alcohol, but very sparingly so in æther. It fuses at 311°, and by destructive distillation furnishes benzol, benzoic acid, salicylous acid the chief constituent of oil of meadow sweet, carbonic anhydride, and hydroquinone $C_6H_6O_2$. Heated with black oxyde of manganese and sulphuric acid, quinic acid, or a kinate, yields quinone (kinone) $C_6H_4O_2$, carbonic anhydride and water, thus :—$C_7H_{12}O_6 + O_2 = C_6H_4O_2 + CO_2 \times 4H_2O$. Quinone forms long

rich yellow prisms which sublime without decomposition, and are condensed on the neck of the flask on which the operation is performed. Hydriodic acid converts quinic acid in benzoic acid. Further, quinic acid is eliminated by the kidneys as hippuric acid.

2. *Quinovic (chinovic) acid*, $C_{24}H_{38}O_4$, occurs only in small quantity; it forms tasteless hexagonal scales, which are insoluble in water, æther, or chloroform, and only freely soluble in boiling alcohol.

3. *Cincho-tannic acid*, $C_{14}H_{12}O_7,H_2O$, an amphorous deliquescent body, very soluble in water, alcohol, and æther. The solutions are turned green by perchloride of iron, and precipitate gelatin and emetic tartar. The acid when subjected to destructive distillation yields pyrocatechin. In contact with alkalies the acid is decomposed, flocculi of cinchona-red, or cincho-fulvic acid, being precipitated.

Cinchona-red (cincho-fulvic acid), $C_{12}H_{14}O_7$, exists naturally in the bark, giving to it the reddish-brown colour. With an alkali it forms an intensely red solution. By long boiling in water, cinchona bark is exhausted of its alkaloids and of the quinic and cincho-tannic acids. On the addition of slight excess of milk of lime to the decoction, the alkaloids and cincho-tannic acid are precipitated, and calcic quinate remains in solution. Crystals of this salt are deposited on evaporating the filtrate, and the quinic acid is set free by the cautious addition of tartaric and quinic acid, and may be readily crystallised. The quinovic and cincho-fulvic acids may be removed from the exhausted bark by solution of ammonia.

On the addition of hydrochloric acid to the ammoniacal infusion, both acids are precipitated. They may be separated by boiling with milk of lime, the quinovate of lime being soluble, the cincho-fulvate insoluble. The acids may be separated from the lime by the cautious addition of oxalic or sulphuric acid.

Besides the alkaloids and acids, cinchona bark contains certain other vegetable principles. A thick *volatile oil*, with an acrid taste and the peculiar odour of the bark, has been obtained from it. Also a concrete *fat*, capable of forming soaps with alkalies. *Salts of lime* have been found in the greatest quantity in those barks which yield most quinia, as the Calisaya bark. *Gum* has been observed to abound most in those which yield most cinchonia, as the pale barks, and to be deficient in the yellow and red barks, whence it has been inferred that the latter are produced by the older parts of their respective trees. *Resin* and *starch* are contained in various proportions. The bulky residue of the bark consists of *ligneous fibre*.

Estimation of the Alkaloids in Cinchona Barks.—The presence of a minute portion of bark or its powder may be readily detected by heating it strongly in a test-tube. The alkaloids in the presence of the volatile acids of the bark are then volatilised, forming rich crimson vapours (Grahe). In order to estimate the quantities of the several alkaloids, De Vry has given the following process:—(1.) Mix 300 grains of the powdered bark dried at 212° with milk of lime (75 grains of slaked lime to 750 grains of water). Dry the mixture slowly, and then boil it with 7 fluid ounces of rectified spirit. Pour off the clear liquid, boil again with half as much more alcohol, filter, and wash the powder with $3\frac{1}{2}$ ounces more alcohol. From the mixed liquors precipitate the calcium as sulphate by a few drops of dilute sulphuric acid. Filter, distil off the spirit, and pour the residual liquid into a capsule, and heat it on a water bath until the spirit is wholly expelled. Filter the remaining liquor, which contains all the alkaloids in the form of acid sulphates, and wash the residue (quinovic acid and fatty matter) with water slightly acidulated with sulphuric acid. The filtrate and washings reduced to about $\frac{1}{2}$ fluid ounce, are now treated while still warm with caustic soda in slight excess. Wash the precipitate with a very little water, press it between folds of blotting paper, and dry on a water bath. The weight divided by 3 gives the percentage of the alkaloids.

1. To separate the alkaloids from each other, shake the mass with ten times its weight of æther. This resolves it into two portions:—A, Insoluble in æther; B, soluble in æther.

A. This should be converted into neutral sulphates and then precipitated by iodide of potassium, which separates any quinidia that may be present. A solution of Rochelle salt will now precipitate crystalline tartrate of *cinchonidia;* and *cinchonia* is separated from the mother-liquor by caustic soda.

B. After evaporation of the æther, dissolve the residue in 10 times its weight of proof spirit, to which $\frac{1}{20}$ of its volume of dilute sulphuric acid has been added. Filter, warm slightly, and add tincture of iodine as long as a precipitate (see p. 559) is formed. 100 parts of the iodosulphate contains 56·5 of *quinia.* To the remaining fluid add a few drops of sulphurous acid, and then evaporate the alcohol and add caustic soda, which will precipitate the amorphous alkaloids, including any *quinamina* that may be present (*Pharm. Journ.* 1873, p. 241).

2. The Pharmacopœia gives the following process for the estimation of the quinia:—Boil 100 grs. of the bark, reduced to very fine powder, for a quarter of an hour in 1 fluid ounce of distilled water acidulated with 10 minims of hydrochloric acid, and allow it to macerate for twenty-four hours. Transfer the whole to a small displacement tube, and after the fluid has ceased to percolate add at intervals about $1\frac{1}{2}$ ounce of similarly acidulated water, or until the fluid which passes through is free from colour. Add to the percolated fluid solution of subacetate of lead until the whole of the colouring matter has been removed, taking care that the fluid remains acid in reaction. Filter and wash with a little distilled water. To the filtrate add about 35 grains of caustic potash, or as much as will cause the precipitate which is at first formed to be nearly redissolved, and afterwards 6 fluid drachms of pure æther (or chloroform). Then shake briskly, and, having removed the æther, repeat the process twice with 3 fluid drachms of æther, or until a drop of the

æther employed leaves on evaporation scarcely any perceptible residue. Lastly, evaporate the mixed æthereal solutions in a capsule. The residue, which consists of nearly pure *quinia*, when dry, should weigh not less than 2 grains, and should be readily soluble in dilute sulphuric acid.

The proportion of alkaloids in cinchona bark is liable to extreme variation. The bark of a particular species grown in one locality may be devoid of quinia, and when grown in another may yield 3 or 4 per cent. (Karsten). De Vry found a variation of from 11·96 to 1 per cent. in the quantity of alkaloids contained in the bark of *C. officinalis* when the plant was grown in the same district. The variation is one not only of total percentage, but also in the proportion which the alkaloids bear to each other. Quinia and cinchonia are most frequently present; quinidia is only occasionally met with, and never in very large quantity. Cultivation has great influence in the development of the alkaloids.

Good Calisaya bark usually contains from 5 to 6 per cent. of quinia. Crown or Loxa bark is very variable, that obtained from young trees often contains but traces of quinia and cinchonia, but the bark from old trees is often equal to the best Calisaya.

Red bark is also very variable, yielding from 3 to 10 per cent. of alkaloids, a third of which is quinia, a fourth cinchonidia, the remainder cinchonia and quinidia. The thick, flat bark yields much less than the quilled.

The following list contains the principal species of cinchona, yielding the several kinds of bark used directly in medicine, or for the preparation of the alkaloids:—

1. *Cinchona officinalis* var. *Condaminea*, Hook., *Bot. Mag.* 5364. Loxa or pale brown bark. *Hab.* Loxa. Cultivated in India.
2. *C. macrocalyx*, Pav., *Howard's Illust. of the Nueva Quinologia of Pavon.* Ashy brown bark. The var. *Palton* furnishes Palton bark, an important source of quinia. *Hab.* Peru.
3. *C. lancifolia*, Mutis, *Karst.* t. 11, 12. Columbian bark, one of the principal sources of quinia. *Hab.* New Granada. Cultivated in India.
4. *C. Pitayensis*, Wedd., *Karst.* t. 22. Pitayo bark, a valuable kind, and the chief source of quinidia. *Hab.* New Granada. Cultivated in India.
5. *C. micracantha*, Ruiz and Pavon,
6. *C. nitida*, Ruiz and Pavon,
7. *C. Peruviana*, Howard; *Howard's Illus. Nuev. Quin.* Grey bark. Huanuco or Lima bark. This is largely used on the Continent. *Hab.* Peru. Cultivated in India.
8. *C. Calisaya*, Wedd., *Wedd.* t. 9. Calisaya, Bolivian or yellow bark, greatly esteemed. *Hab.* Peru, Bolivia. Cultivated in Mexico, Jamaica, India, Ceylon.
9. *C. succirubra*, Par., *Howard's Illust. of Nuev. Quin.* Red bark, the chief source of cinchonidia. *Hab.* Ecuador. Much cultivated in Jamaica, India, Ceylon, and Java.
10. *C. cordifolia*, Mutis, *Karst.* t. 8. Yields a portion of Columbian

bark, and is used for the extraction of quinia. *Hab.* New Granada, Peru.

11. *C. pubescens*, Vahl, *Weddell, Hist. Nat. des Quinquinas*, t. 16. Arica bark. *Hab.* Ecuador, Peru, Bolivia.

Some varieties of the latter species contain aricia. *C. Mutisii*, Lamb, contains this alkaloid exclusively.

These barks are conveniently arranged in three classes, namely—1, *Yellow barks;* 2, *Pale barks;* and 3, *Red barks.* This subdivision is adopted by the Pharmacopœia, and the barks of the three species of cinchona described below may be taken as typical representatives of these three classes.

1. CINCHONA CALISAYA, *Wedd.* Yellow-Bark Cinchona.

This magnificent species grows in declivities and steep and rugged places of the mountains, at an altitude of from 5000 to 6000 feet, raising its leafy head above the other trees of the hottest forests of the valleys of Bolivia and Southern Peru; between 13° and 16° 30′ south latitude, and from 64° to 70° west longitude; in the Bolivian provinces near La Paz of Enquisivi, Yungas, Larecaja or Sorata, and Caupolican or Apolobamba; and in the Peruvian province of Carabaya. It flowers in April and May.

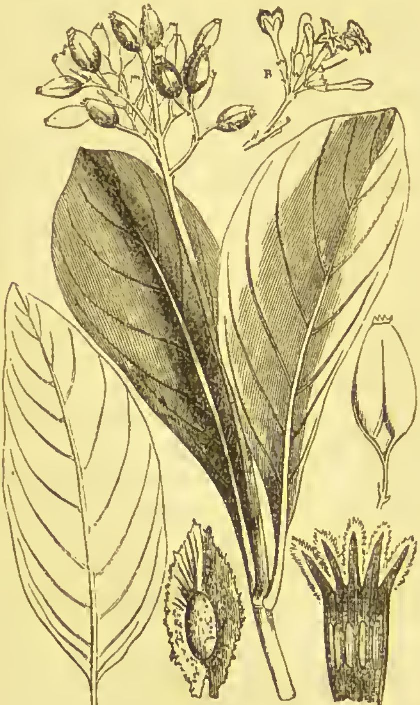

Fig. 91.—*Cinchona Calisaya.*

Fructiferous branch. (From a specimen collected by Weddell in the province of Carabaya, in Peru.) B. Flowers. C. Corolla laid open (magnified in proportion.) D. Capsule (magnified in proportion.) E. Seed (magnified in proportion). F. Leaf of var. *Josephiana.* (From a specimen gathered in the provinces of Yungas, In Bolivia.)

Characters.—*Trunk* straight or bent, often 3 feet in diameter. *Leaves* 3 to 6 inches, oblong or lanceolate-obovate, obtuse, attenuated at the base, smooth. *Flowers* pinkish, in large pyramidal panicles. *Filaments* about $\frac{1}{3}$ the length of the anthers. *Capsule* ovate, about the same length as the flowers ($\frac{1}{2}$ inch). Wing of the *seeds* usually fimbriate-denticulate.

β. JOSEPHIANA.—A shrub with somewhat acute, oblong-lanceolate, or ovate-lanceolate leaves; 6 to 10 feet high, with a slender branched trunk of from 3 to 5 centimetres thick. *Branches* erect. *Bark* adhering firmly to the wood; that of the trunk and branches schistaceo-blackish, smoothish, or furnished with different lichens, and marked in an annular manner by some narrow, distant fissures; that of the branchlets reddish-brown. This variety is called both *Ichu Cascarilla* and *Cascarilla del Pajonal*, both names signifying herbaceous cinchona.—*Weddell, His. Nat. des Quinquinas*, plates 3, 3 *bis*, and 28.

Cinchonæ flavæ cortex, *P.B.* *Yellow Cinchona Bark.*

The bark of the tree above described, collected in Bolivia and Southern Peru, where it is known as *Cascarilla Colisaya* and *Calisaya* (*Collisalla*, Pöpping).

Characters and Tests.—In flat pieces, uncoated or deprived of the periderm, rarely in coated quills, from 6 to 13 inches long, 1 to 3 wide, and from 2 to 4 lines thick, compact and heavy; outer surface brown, marked by broad, shallow, irregular, longitudinal depressions; inner surface tawny-yellow, fibrous; transverse fracture shortly and finely fibrous. Powder cinnamon-brown, somewhat aromatic, persistently bitter. The quilled bark, the rolls of which are from ¾ to 1½ inch wide, have a thick, rugged, corky layer, and the laticiferous vessels are well developed in the younger quills.

100 grains of the powdered bark treated with hydrochloric acid, &c., as described p. 562, should yield not less than 2 grains of dry residue, which consists of nearly pure quinia, and should be readily soluble in dilute sulphuric acid. The bark often yields as much as 4 per cent. of quinia.

Quiniæ sulphas, *P.B.* *Sulphate of Quinia.* $C_{40}H_{24}N_2O_4,HOSO_3+7HO=373+63$ or $(C_{20}H_{24}N_2O_2)_2H_2SO_4 7,H_2O=746+126$.

This is the neutral sulphate. It is thus prepared:—Dilute 3 fluid ounces of *hydrochloric acid* with 10 pints of *water*. Place 1 pound of *yellow cinchona bark* in coarse powder in a porcelain basin, and add to it as much of the diluted hydrochloric acid as will render it thoroughly moist. After maceration, with occasional stirring for twenty-four hours, place the bark in a displacement apparatus, and percolate with the diluted hydrochloric acid until the solution which drops through is nearly destitute of bitter taste. Into this liquid pour 4 pints of *solution of soda*, agitate well, let the precipitate completely subside, decant the supernatant fluid, collect the precipitate on a filter, and wash it with cold water until the washings cease to have colour. Transfer the precipitate to a porcelain dish containing a pint of water; and applying to this a steam heat, gradually add dilute *sulphuric acid* until very nearly the whole of the precipitate has been dissolved, and a neutral liquid has been obtained. Filter the solution while hot, wash the filter with boiling water, concentrate till a film forms on the surface of the solution, and set it aside to crystallise. The crystals should be dried on filtering paper without the application of heat.

The acid dissolve out the quinia in the form of hydrochlorate, setting free kinic acid (see p. 560). The soda combines with both of these acids, forming soluble salts, and precipitates the quinia. This is washed, dissolved in dilute sulphuric acid, and the solution evaporated to obtain crystals of the sulphate.

Manufacturers find it cheaper to precipitate the alkaloid with lime. The precipitate, pressed into a cake between folds of calico, is acted on by rectified spirit, which dissolves out the quinia.

Characters and Tests.—Filiform silky snow-white crystals, of a pure intensely bitter taste, soluble in 60 parts of rectified spirit and in 740 parts of cold and 30 of boiling water, imparting to it a peculiar bluish tint. The solution gives, with chloride of barium, a white precipitate (sulphate of baryta) insoluble in nitric acid; and when treated first with solution of chlorine and afterwards with ammonia, it assumes a splendid emerald-green colour. It dissolves in pure sulphuric acid with a feeble yellowish tint, and undergoes no further change of colour when gently warmed (absence of salicin, sugar, mannite, gum, starch, and organic matters generally). 10 grains, with 10 minims of diluted sulphuric acid, and ½ ounce of water, form a perfect solution, from which ammonia throws down a white precipitate. This redissolves on agitating the whole with ½ fluid ounce of pure æther, without the production of any crystalline matter (cinchonia, which is nearly insoluble in æther) floating on the lower of the two strata, into which the agitated fluid separates on rest. The upper stratum of fluid, if entirely removed by a pipette and evaporated, leaves a white residue, which, when dried in the air without heat, weighs 8·6 grains (of quinia, the proper proportion). In dry air the crystals lose five molecules of water of crystallisation. At 212° the salt becomes phosphorescent, and 25 grains are reduced to 16·4; at 240° it fuses, loses the remainder of the water of crystallisation, then becomes red, and at last ignites and burns away, leaving no residue. Sulphate of quinia is very soluble in water acidulated with sulphuric acid, being converted into the more soluble acid sulphate, $C_{20}H_{24}N_2O_2H_2SO_4,7H_2O$, the solution exhibiting a beautiful blue fluorescence.

Adulterations.—The chief of these are indicated above. Warm sulphuric acid, by reddening *salicin* and charring *sugar*, *flour, and other orgaic matters*, at once indicates the presence of these. *Phloridzin*, a bitter-sweet principle, forming silky crystals, derived from the bark of pomaceous and amygdalaceous trees, has been found, mixed with sulphate of quinia, in a few instances. Although nearly insoluble in cold, it is freely dissolved by boiling water, and it is nearly insoluble in æther. Exposed to the vapour of ammonia it assumes a beautiful blue colour; nitric acid also detects its presence by turning the quinine first yellow, then green, and finally dark-brown. *Stearic and other fatty acids* would remain after solution of the sulphate in acidulated water. *Inorganic substances*, such as effloresced sulphate of zinc or sulphate of lime, are readily detected either by insolubility in alcohol or acidulated water, or as residue after combustion. *Ammoniacal salts*, such as the hydrochlorate, evolve ammonia when heated with potash. As it comes from the manufacturer, such crude adulterations of sulphate of quinia are rarely or never met with; but they may be imposed by an unprincipled vendor.

Action.—The remedial effects of cinchona depend upon the three constituents,—cincho-tannic acid, quinic acid, and the alkaloids. Cincho-tannic acid (see p. 561) is powerfully astringent, and agrees in its action with tannic acid. Quinic acid is chemically allied to benzoic acid, and like this substance is converted in the body into hippuric acid, and eliminated as such by the kidneys: the action of quinic acid may therefore be regarded as similar to, if not identical with, that of benzoic acid (see p. 527). The proper effects of cinchona are, of course, due to its alkaloids, and as these are identical in their action, differing only in degree, quinia, or perhaps quinidia, being the most potent of them, quinia may be taken as the type of them.

The effects of quinine are very obvious and remarkable, but how they are produced is still an obscure problem. It will be well to first consider these effects, and then to seek some explanation of the mode in which they are induced. Large doses of sulphate of quinia (15 to 20 grains) cause in a delicate or susceptible person the following effects:—headache, with a sense of fulness, and some nausea, ringing noises in the ears, and more or less deafness; bright flashes of light, with some confusion in the field of vision, giddiness, insomnia, and slight delirium. These symptoms collectively are termed *cinchonism* or *quinism;* after continuing for two or three hours they gradually decline, except the headache and nausea, which usually persist for several hours. If the dose exceed 25 or 30 grains, the headache is intense, the delirium may be very decided, the deafness complete, and there may be partial blindness and dilatation of the pupils. Recovery has followed the ingestion of 400 grains; but this large dose caused severe delirium, general muscular relaxation, with a tendency to convulsions, enfeeblement of the breathing, complete deafness and blindness, and a near approach to collapse.

The pulse, breathing, and temperature are not appreciably affected by a large medicinal dose of the drug; but a frequent repetition of it causes slight depression of the pulse and respiration, and a corresponding diminution of temperature. Sometimes cinchonism is prevented by a speedy rejection of the dose; but this, I think, is due to the intensely bitter impression on the palate, and may be prevented by giving the medicine in the form of pill. The commonest effect of moderate doses of quinine in susceptible persons is headache and nausea. But the most remarkable effect of quinia is exhibited in intermittent fever. In every variety of ague its action is specific and remedial. Under its influence the attack is postponed and weakened, and, if the dose be sufficient, the disease is completely defeated. Nor does it merely remove the outward symptoms of the disease—the shivering and fever—but it removes the cause, and not only the cause, but its effects. Thus, if the ague take the form of neuralgia, it disappears as speedily as the ordinary fit, and the associated enlargement of the spleen disappears under its use.

Such are the general effects of quinia in health and disease.

When we come to inquire what is its local action, we find that this, in reference to the bodies of the higher animals, is not very appreciable, but it has a decided toxic effect on the lowest forms both of animal and vegetable life. Thus, it has been shown, that a solution of 1 part of quinia in 800 of water immediately destroys large infusoria, such as *Paramecia* and *Colopoda*, and vigorous fungi, such as *Penicillium* and *Torula cerevisiæ*. A rather stronger solution is necessary to arrest the movements of *Vibrios* and *Bacteria*. Owing to its toxic influence on these germs of life, quinia arrests both putrefaction and fermentation: a solution of 1 part in 300 of water checks alcoholic fermentation, and preserves flesh, butter, solutions of gelatin and albumin, milk, and urine for a considerable time,—probably until the quinia itself is decomposed. Further, Zunst and A. Schultze have shown that the presence of quinia prevents the formation of acid in blood after it has been drawn from the vessels; and its influence in this case may probably be traced to the cause above mentioned, viz., the power of preventing the germination of the minute organisms on which the acidifying process may be assumed to depend. Binz finds, further, that quinia retards the oxydation of guaiacum (see Guaiacum) by blood, to which the production of the blue colour is due. The same observer states that quinia exercises a direct influence on the blood corpuscles, diminishing the oxydising function of the red, and arresting the amœboid movements of the white corpuscles, upon which their extension is supposed to depend. There is no doubt that in a condition of relaxation of the capillaries approaching stasis, the white corpuscles are readily extruded through the soft yielding walls of these filmy tubes. But I think that the influence of quinia in preventing this so-called migration of the white corpuscles is due, not to a direct action on these bodies, but to a tonic influence on the capillary wall; and I am strongly of opinion that the beneficial influence of quinia in ague and the removal of splenic swelling, must be attributed to this effect on the blood-vessels by which the congestion is relieved, rather than to a restraining influence on the movements of the white corpuscles, or leucocytes, as they have been termed. If these latter were indeed a species of entozoa, capable of an independent existence like the infusoria, then the direct influence of quinia may be admitted; but our knowledge of the white corpuscle of the blood does not warrant this view of its relationship. The following plausible theory of the specific action of quinine in ague must therefore be received with extreme caution. It is given here more as an incentive to further inquiry than as a probable explanation of one of the most obscure problems of medicine. This theory is due to Professor Binz of Bonn, and is as follows:—"The action of quinia on the lower organisms stands in close relation to that on the leucocytes of the blood. It is able to paralyse their spontaneous movements and to check their migrations. It cures malarial cachexia by acting directly upon the central cause of those manifestations, whether this be an organised germ or some albuminoid material in a state of change. Its curative action is not exerted through the nervous system. Tinnitus, vertigo, drowsiness, and other symptoms of quinism in man, may possibly be due to a partial anæmia of the brain. Quinia paralyses the irritant miasm by virtue of its antiseptic quality, and so in ague limits the corpuscular proliferation in the splenic parenchyma, and by limiting the oxydising processes, and thus reducing the functional activity, the blood supply lessens, and the organ shrinks."

One point remains for consideration, namely, an explanation of the effects which have been termed cinchonism. What is the cause of the headache, the delirium, the deafness, and the blindness? We have seen that these symptoms are independent of any remarkable alteration in the rate of the blood or the size of the blood-vessels. Evidence of the direct influence of quinia on the white corpuscles is conflicting; but if it were granted that it caused paralysis of them, the phenomena above mentioned could not fairly be attributed to this cause; for it would appear, from our knowledge of the development of the blood corpuscles, that the presence of the small proportion of white ones in the blood is rather accidental than necessary. Discarding this cause as insufficient, can we attribute the effects to an interference with the oxydising function of the red corpuscle? The oxydes of carbon undeniably reduce the oxydising function of the blood, and produce headache, giddiness, delirium, with diminution of special sensation, symptoms which so far agree with those of cinchonism—but there is also somnolency rapidly passing into coma—whereas insomnia is a prominent part of cinchonism. Furthermore, diminution of the oxydising function of the blood speedily results in an increase of uric acid in the urine. But the reverse of this is the case under the use of quinia: thus Ranke, G. Kerner, and Rabuteau agree in the observation that the quantity of uric acid is greatly decreased. Kerner states, that after so large a dose as 38 grains, it was reduced to $\frac{1}{6}$ of the initial amount; the urea and phosphoric acid meantime were only reduced about $\frac{1}{4}$. Nor has any observer noted any appreciable loss of the natural temperature under the influence of quinia. The theory, then, of a diminution of oxydising function, derived indeed from very crude and unsatisfactory experiments, must also be regarded as untenable, and we must attribute the cinchonism to a direct effect of the quinia on the nerve tissue. Quinia is absorbed into the blood, is retained in solution (*Kerner Pflüger's Archiv. für Physiol.* 1870), as such appears in all the secretions, and is slowly eliminated by the kidneys, slightly or not at all unchanged, excepting that it is in an amorphous condition. The nervous tissue is therefore exposed to the direct action of quinia; and in the absence of evidence to the contrary, we may be content to conclude that the peculiar effects known as cinchonism are the result of this direct action on the nerve vesicles. It would appear that this action is in its nature an astringent one in moderate doses, rendering the nervous action slower and more energetic, and in large ones restraining, and even interrupting it, as in the production of amaurosis and deafness. This theory will explain the remedial action of quinia. Its beneficial influence is seen in those cases where, so to speak, the nervous system is unstrung,—where, from sheer debility and relaxation of the nerve vesicles, the nerve currents are jarring and painful. The tonic influence of quinia in such a case finds a parallel in the action of cincho-tannic acid on a relaxed mucous membrane.

Medicinal Uses.—Independently of its specific action in ague, quinia may be taken as the type of vegetable tonics. In debility, whether general or local, as in pyrosis, atonic dyspepsia, leucorrhœa, cystitis, &c., it is a beneficial remedy; and the question is, not what particular form of general or local debility will be benefited by quinia, but whether the patient will be able to bear the remedy. In states of great debility it is apt to produce nausea and headache; and if, as so often happens, the stomach is irritable or the bowels are confined, this drug is apt to disagree; and we must either prescribe it in very small doses or wait until some improvement has been effected in the digestive function. In fevers of septic origin quinia is most valuable, an occasional large dose (10 to 20 grains) always influencing to some extent, and usually in a marked degree, the exacerbations of pyrexia which attend enteric and puerperal fevers, dysentery, and pyæmia. It is also useful in rheumatic fever, given in combination with an alkali. In ague and intermittent fever of every form and type, quinia is specific, provided that it be given in sufficient doses (from 8 to 20 grains). It should be given about twelve hours before the expected fit. Small and repeated doses have usually no effect on this disease, whereas two or three efficient doses often remove it completely; and in the severer forms of intermittent fever a dose of 30 to 50 grains every twenty-four hours may be necessary. Its value as a prophylactic in this disease has been fully proved, the dose being from 3 to 5 grains daily, or every other day, according to the degree of the endemic malaria. In neuralgia, especially when associated with ague, and the form known as tic doloureux, quinia is the most effectual remedy we possess, and it must be given in full doses. The exclusive use of quinia has led to the neglect of the other alkaloids of cinchona, which might in many cases be economically substituted for quinia. The Medical Commission of the Madras Government has proved this conclusively in their Report (*Blue-Book, East India Cinchona Cultivation*, 1870). The facts are these: Of 2472 cases of intermittent malarious fever treated, 846 took sulphate of quinia, 664 sulphate of quinidia, 569 sulphate of cinchonia, and 403 sulphate of cinchonidia,—salts specially prepared under Mr Howard's superintendence. There were only 27 failures; the proportion of which, reckoned for a 1000 cases, was—6 for sulphate of quinidia, 7 for sulphate of quinia, 10 for sulphate of cinchonidia, and 23 for sulphate of cinchonia,—quinidia proving to be the most valuable of the alkaloids, and cinchonidia almost as serviceable as quinia. My own observations on the general effects of a natural mixture of the sulphates of the cinchona alkaloids as compared with equal doses of sulphate of quinia, agree with these conclusions; for I found that the latter salt possessed no remedial advantage over the mixed sulphates, and that when the doses were carried beyond the limit of toleration in children and delicate persons, vomiting and headache were produced as readily with the one substance as the other.

Dose.—Of the powdered bark, 10 to 60 grains; of sulphate of quinine, 1 to 10 grains, or more.

Pharmaceutical Uses of yellow bark and sulphate of quinia, the preparation of the articles next following.

3. **Decoctum Cinchonæ flavæ**, *P.B.* *Decoction of Yellow-Cinchona.*

Preparation.—Boil 1¼ ounce of *yellow-cinchona bark* in coarse powder with 1 pint of *water*, for ten minutes in a covered vessel; strain when cold, and wash the bark with enough water to make 1 pint of the decoction.

Only a portion of the alkaloids is extracted by boiling water, and much of this is precipitated on cooling by the cincho-tannic acid, the hot, clear decoction becoming quite turbid. The residual bark contains a considerable quantity of quinia.

Dose.—1 to 3 fluid ounces as an astringent and tonic.

4. **Infusum Cinchonæ flavæ**, *P.B.* *Infusion of Yellow-Cinchona.*

Prepared by infusing ½ ounce of *yellow-cinchona bark* in 10 fluid ounces of *boiling water* for two hours, and straining.

This contains about the same quantity of the alkaloids as the previous preparation.

Dose.—1 to 2 fluid ounces.

5. **Extractum Cinchonæ flavæ liquidum**, *P.B.* *Liquid Extract of Yellow-Cinchona.*

Preparation.—Macerate 1 pound of *yellow-cinchona bark* in coarse powder in 2 pints of *water* for twenty-four hours, stirring frequently; then pack in a percolator, and add more water, until 12 pints have been collected, or the water ceases to dissolve any more. Evaporate the liquor at a temperature not exceeding 160° to a pint; then filter through paper, and continue the evaporation to 3 fluid ounces, or until the sp. gr. of the liquid is 1·200. When cold, add 1 fluid ounce of *rectified spirit* gradually, constantly stirring. The sp. gr. should be about 1·100.

This preparation naturally contains but a small proportion of the alkaloids, but, as it is usually found, it yields next to none. It should be discarded from the Pharmacopœia, which is so rich in astringent preparations.

Dose.—10 to 30 minims.

6. **Tinctura Cinchonæ flavæ**, *P.B.* *Tincture of Yellow-Cinchona.*

Prepared by exhausting 4 ounces of *yellow-cinchona bark* with 1 pint of *proof spirit* in the manner prescribed for Tinctura aconiti, and obtaining 1 pint of the tincture.

Dose.—½ to 2 fluid drachms.

7. **Tinctura Quiniæ,** *P.B.* *Tincture of Quinia.*

Preparation.—Dissolve 160 grains of *sulphate of quinia* in 1 pint of *tincture of orange-peel* with the aid of a gentle heat. After three days with occasional shaking, filter.

Mr Hemingway has found that, even without using heat, the whole is dissolved with the exception of a very trifling precipitate. It seems that this solvent power is partly due either to a natural vegetable acid in the peel, or to its having been wet with the orange juice before drying. (*Pharm. Jour.* xi. 68.)

8. **Tinctura Quiniæ ammoniata,** *P.B.* *Ammoniated Tincture of Quinia.*

Preparation.—Dissolve 160 grains of *sulphate of quinia* in 17½ fluid ounces of *proof spirit* with a gentle heat, and add 2½ fluid ounces of *solution of ammonia.*

Quinia is soluble in a slight excess of alkali, and this is a convenient form of quinia in cases such as rheumatism, where the use of an acid may be objectionable.

Dose.—½ to 2 fluid drachms = ½ to 2 grains of the salt.

9. **Vinum Quiniæ,** *P.B.* *Quinia Wine.*

Preparation.—Dissolve 30 grains of *citric acid* in 1 pint of *orange wine,* and then 20 grains of *sulphate of quinia;* allow the solution to remain for three days, occasionally shaking it, and then filter. Some white wines, notably Madeira, contain sufficient acid to dissolve this quantity of sulphate of quinia.

Dose.—½ to 1 fluid ounce = ½ to 1 grain of the sulphate.

10. **Pilula Quiniæ,** *P.B.* *Quinine Pill.*

A mixture of 60 grains of *sulphate of quinia* and 20 grains of *confection of hips.*

Dose.—2 to 10 grains = 1½ to 7½ grains.

11. **Ferri et Quiniæ citras,** *P.B.* See Preparations of Iron, p. 221.

2. CINCHONA OFFICINALIS, *Linn.*, Var. *α.* CONDAMINEA.
Pale-Bark Cinchona.

This, the first known species, was most wastefully cut down in Peru before the year 1779, and for a time one of the finest varieties Loxa bark (*Cuscarilla fina de Uritusinga*) had nearly disappeared from commerce.

Characters.—A *tree* about 30 to 45 feet in height, with opposite branches, which are horizontal in the lower parts, but form above an acute angle with the stem, smooth as high as the inflorescence, with lanceolate *leaves,* ovate or somewhat roundish, usually acute, above very smooth, shining, below sometimes pitted in the axils of the veins. *Flowers* small. *Peduncles* panicled, corymbose in the axils of the upper leaves, forming a large loose *thyrse,* covered with a short thick down. *Calyx* downy, like the pedicles. *Limb* very short, urceolate, 5-toothed, pubescent. *Corolla* slender, about four times as long as the tube of the calyx, tomentose; limb very shaggy internally. *Filaments* about half the length of, or longer than the anthers. *Capules* oblong-ovate, scarcely twice as long as broad. See plates 1 and 2, Howard's "Illustrations" (*C. chahuarguera* and *C. crispa*); *Pavon MS.* *Habitat.*—*C. officinalis* occupies a belt of vegetation extending from 5700 to 7700 feet above the sea, having a mean temperature of from 64°–68°. The variety *lancifolia* may be found at the height of 10,000 feet nearly, and it must therefore be sometimes exposed to frost.

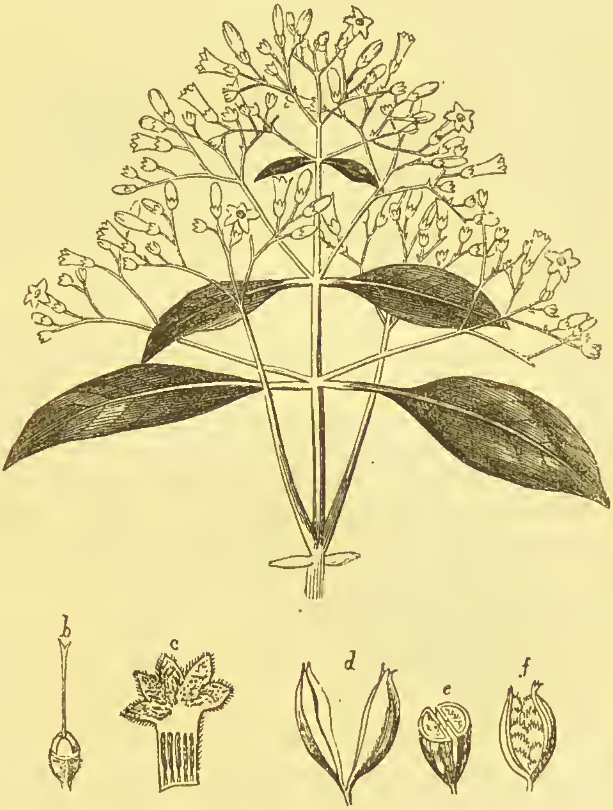

Fig. 92.—*Cinchona officinalis* var. *Condaminea*.
a, calyx; *b*, pistil; *c*, corolla (opened); *d* and *e*, capsule; *f*, a cell of the fruit; *g*, seed.

The bark of this species (*Cascarilla fina de Uritusinga, Quinquina gris-brun de Loxa*) was used by the royal family of Spain, and so acquired the name of *crown-bark*.

1. **Cinchonæ pallidæ cortex,** *P.B.* *Pale Cinchona Bark.*

The bark of *Cinchona Condaminea*, Decand., vars. *chahuarguera*, Pavon, and *crispa*, Tafalla, collected about Loxa in Ecuador.

Characters and Test.—From ½ to 1 line thick; in single or double quills, from 6 to 15 inches long and 2 to 8 lines in diameter; brittle, easily splitting longitudinally, and breaking with a short tranverse fracture; outer surface brown and wrinkled, or grey and speckled with adherent lichens, with or without numerous transverse cracks; inner surface bright orange or cinnamon brown; powder pale brown, slightly bitter, very astringent.

This bark, as indicated by the smallness of the quills, is taken from young wood. Laticiferous vessels are present in the finest quills, and the cells of the mesophlœum do not exhibit either crystalline or resinous deposit.

200 grains of the powdered bark treated as directed under 2, page 562, chloroform being substituted for æther, yield not less than 1 grain of alkaloids. Mr Howard found some fine specimens of crown-bark, though old and in fine quills, to contain 0·714 per cent. of quinia, 0·514 of quinidia, 0·04 of cinchonia. Other and more modern specimens yielded only quinidia from 0·57 to 1·05 per cent. and cinchonia from 0·06 to 0·08 per cent. Dr Vry found that the yield of alkaloids in specimens of the bark grown at Ootacamund varied from 1 to 11·96 per cent., some containing as much as 9 per cent. of quinia. The proportion of cincho-tannic acid is greater than in the yellow and red barks.

Dose.—Of the powder 10 to 60 grains.

Pharmaceutical Uses.—The preparation of the following.

2. **Tinctura Cinchonæ composita,** *P.B. Compound Tincture of Cinchona.*

Prepared by exhausting 2 ounces of *pale-cinchona bark* in moderately fine powder, 1 ounce of *bitter orange-peel* cut small and bruised, ½ ounce of *serpentary root* bruised, 60 grains of *saffron*, and 30 grains of *cochineal* in powder, with 1 pint of *proof spirit*, in the manner directed for tincture of aconite, and obtaining 1 pint of the tincture.

A stimulant and astringent tonic.

Dose.—½ to 2 fluid drachms.

3. **Mistura ferri aromatica,** *P.B.* See Preparations of Iron, p.219.

3. CINCHONA SUCCIRUBRA, *Pavon.* Red-Bark Cinchona.

This is described by Pavon as the species yielding the red bark of commerce. It is found in the forests on the western declivities of Chimborazo, from 2000 to 5000 feet above the sea-level. Mr Howard has described the bark of this tree as the true red bark. The accompanying cut is taken from his *Illustrations.*

Characters.—A lofty *tree*, with solitary erect trunk, sometimes two or three springing from the same root, very leafy and branched. *Wood* compact. *Bark* brown, with some white spots, and transverse horizontal furrows. *Leaves* opposite stalked, ovate-oval, entire, shortly pointed, glabrous, slightly shining, strongly veined, the younger ones re exed at the margin. *Stipules* subamplexicaul, oblong, sessile, deciduous. *Flowers* in paniculate racemes; handsome, reddish pink. *Petals* ciliated, expanding in July and August. *Capsule* oblong, slightly curved, bivalved, parted at the base.—*Pavon MS. Nueva Quinologia; Howard's Illustrations*, pl. 9.

Red cinchona bark was early known, but not distinguished in

England until 1779. It is the *Rothe-china* of Bergen, and *Quinquina rouge* or *Cascarilla colorado* of the Spaniards.

1. **Cinchonæ rubræ cortex,** *P.B.* *Red Cinchona Bark.*

The bark of the tree above described, collected on the western slopes of Chimborazo.

Characters and Test.—In flat or in curved pieces, less frequently in quills, coated with periderm, varying in length from a few inches to 2 feet, from 1 to 3 inches wide, and 2 to 6 lines thick; compact and heavy; outer surface brown or reddish-brown, rarely white from adherent lichens, rugged or wrinkled longitudinally, frequently warty, and crossed by deep transverse cracks; inner surface redder; fractured surface often approaching to brick-red; transverse fracture finely fibrous; powder red-brown; taste bitter and astringent. 100 grains treated in the manner directed under 2, page 562, substituting chloroform for æther, should yield not less than 1·5 grain of alkaloids. The thick, flat bark contains less alkaloids and more colouring matter than the quilled pieces, which sometimes yield from 5 to 10 per cent. of the alkaloids, about $\frac{1}{3}$ of which is quinia, $\frac{1}{4}$ cinchonidia, the remainder being quinidia and cinchonia. The thick red bark affords about 10 per cent. of cinchona-red, a larger quantity than is contained in the other kinds of bark.

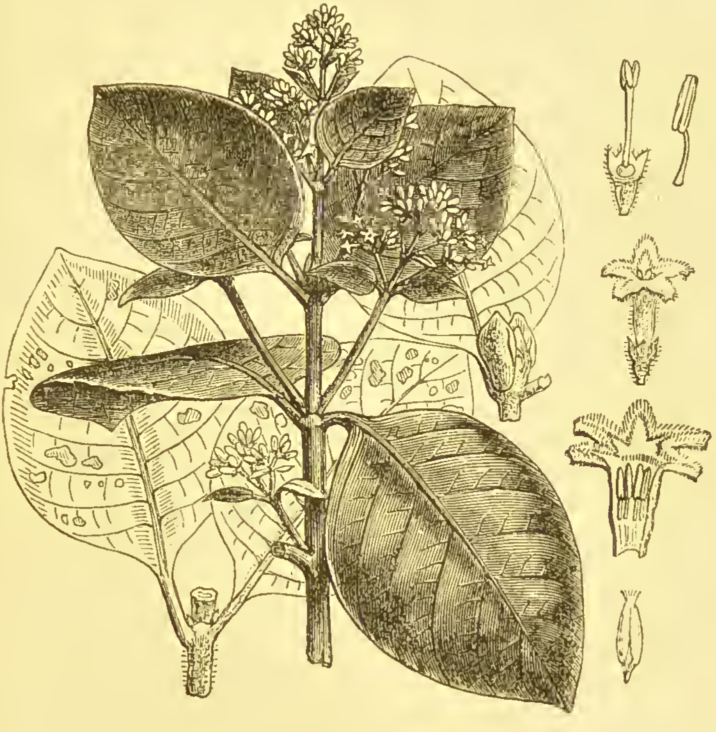

Fig. 93.—*Cinchona succirubra.*

Dose.—Of the powder, 10 to 60 grains.

CAPRIFOLIACEÆ, *Juss.* The Honeysuckle Family.

This order is distinguished from the Cinchonaceæ by an irregular corolla, succulent fruit, and the absence of stipules.

SAMBUCUS NIGRA, *Linn.* The Elder.

The elder, indigenous in Europe, was known to the Greeks, and called *ἀκτή* by Dioscorides.

Characters.—Arborescent; much and always oppositely branched; young branches filled with spongy pith. *Leaves* pinnate; leaflets usually 2 pairs with an odd one, ovate, serrate, cuspidate. *Cymes* large, terminal, with 5 principal branches. *Calyx* limb 5-cleft. *Corolla* cream-coloured, rotate, 5-lobed, finally reflexed, with a faint scent. *Stamens* 5. *Stigmas* 3, sessile. *Berry* globular, black or greenish-white, 3–4 seeded.—*Woodv. Med. Bot.* pl. 76.

The elder has been long used in medicine, but it does not appear to possess any special qualities. A bright green oil ("Oleum sambuci viride") is prepared by boiling the leaves in linseed oil until they are crisp. This is made into an ointment ("Unguentum sambuci viride"), and both of those preparations retain a reputation for healing among the country people. The inner bark of the elder tree has been used as a cathartic. The fragrant flowers are alone used in modern medicine. They yield a small quantity of volatile oil of the consistence of butter, and traces of volatile acids. The oil is easily altered by exposure to the air. The flowers part with this fragrant oil when infused with hot oil or melted lard, and form respectively "Oleum" or "Unguentum sambuci florum." They retain their fragrance, but somewhat altered, when dried.

1. **Sambuci flores,** *P.B.* *Elder Flowers.*

The fresh flowers from indigenous plants.

Characters.—Flowers small, white, fragrant, crowded in cymes.

2. **Aqua Sambuci,** *P.B.* *Elder Flower Water.*

Preparation.—Place 10 pounds of fresh *elder flowers*, separated from stalks (or an equivalent quantity of the flowers preserved while fresh with common salt), in a still with 2 gallons of *water*, and distil 1 gallon.

The flowers are readily separated from their stalks by throwing the cymes together in a heap for a night. A little heat is developed by which the petals are loosened, and they may then be shaken off with the least touch.

This water is used to give a pleasant odour and flavour to lotions and mixtures.

UMBELLIFERÆ, *Juss.* The Parsley Family.

This order is easily recognised by very distinct features—an umbellate inflorescence, an inferior dicarpellary ovary, obsolete calyx, distinct petals, and a fruit separating into two monospermous carpels, each of which, when ripe, is suspended by a carpophore, and has usually 5 distinct ridges, and in the intervening grooves linear receptacles for volatile oil in the substance of the pericarp, called vittæ. The medicinal properties of the order, which includes the carrot, parsnep, celery, and angelica, are illustrated in the dill, assafœtida, and hemlock.

CARUM CARUI, *Linn.* Common Caraway.

Caraway was known to the Greeks. It is very widely distributed, being found, apparently wild, from Morocco to Iceland and Finland, and as far east as the Western Himalaya. The fruits were known to the Arabians, and it appears that we derive our name for them for the Arabic *Karawya*, by which they are still known in the East.

The plant is extensively cultivated on the clay land of Essex and Kent. The biennial plant is cut in July, and yields from 4 to 8 cwt. of fruit per acre.

Characters.—Biennial, about 2 feet high. *Root* fusiform. *Leaves* bipinnate: *leaflets* cut into linear segments. *Involucre* wanting, or of one leaf; *involucel* none. *Calyx* obsolete. *Petals* 5, obcordate, with a narrow acute inflexed point. *Fruit* aromatic, oblong, a little curved, brownish-coloured. *Carpels* with 5 filiform ridges. Interstices with single *vittæ. Stylopodium* depressed.—*Habitat,* meadows and pastures throughout Europe.—*Woodv. Med. Bot.* pl. 45.

1. **Carui fructus,** *P.B. Caraway Fruit.*

The dried fruits cultivated in England and Germany.

Characters and Constituents.—Fruit usually separating into two parts, which are about 2 lines long, slightly curved, tapering at each end; brown, with 5 paler longitudinal ridges; having an agreeable aromatic odour and spicey taste. These fruits, like those of all other umbelliferous plants, resemble seeds on account of the adhesion of the seed to the seed-vessel. The seed is composed of horny albumin, enclosing at one end a minute embryo. It is closely invested by the pericarp, which is raised into ridges, between which and in the substance of the pericarp are found the receptacles in which the volatile oil is stored.

Of the medicinal fruits of this order those of the caraway and hemlock most closely resemble each other, but they are easily known, caraway fruits being longer and thinner, browner, having even ridges, and an aromatic taste.

The essential constituent of caraway is *volatile oil,* of which the fruits yield from 3 to 6 per cent.

Pharmaceutical Uses.—A constituent of Confectio opii (1 part in 10 nearly), C. piperis (3 parts in 20), Pulvis opii compositus (1 part in $2\frac{1}{2}$), Tinctura cardamomi composita, T. Sennæ, and in the preparation of the following:—

2. **Oleum Carui,** *P.B. Oil of Caraway.*

The oil distilled in Britain from caraway fruit.

Characters and Composition.—Colourless or pale yellow, sp. gr. 0·938, odour aromatic, and taste spicey.

According to Schweizer and Völckel, it is composed of *carvol* $C_{10}H_{14}O$ and *carvene* $C_{10}H_{16}$, in the proportion $\frac{2}{3}$ of the former to $\frac{1}{3}$ the latter. Carvol, sp. gr. 0.953, boils at 440°; it is isomeric with menthol (see p. 473), myristicol (see p. 464), and thymol (see p. 474). With alcoholic solution of sulphide of ammonium it forms the compound $2(C_{10}H_{14}O),H_2S$, which crystallises in large yellowish acicular prisms. Carvene boils at 343°; it is a limpid, colourless oil, lighter than water, and forms a crystalline solid with hydrochloric acid gas.

Action and Uses.—An aromatic stimulant or carminative, resembling the volatile oils of the mints and thyme, and employed for the same purposes, and chiefly as an adjunct to aperients to prevent griping.

Pharmaceutical Uses.—A constituent of Confectio scammonii and Pilula aloes Barbadensis.

3. **Aqua Carui,** *P.B.* *Caraway Water.*

Prepared by placing 1 pound of bruised *caraway fruit* with 2 gallons of *water* in a suitable apparatus, and distilling 1 gallon.

A pleasant aromatic vehicle for many medicines.

FŒNICULUM DULCE, *Decand.* Sweet Fennel.

Fennel is indigenous throughout Europe. It is the Μάραθρον of the Greeks, and was used by the Romans. In the south of Europe the young shoots (*turiones fœniculi*) are brought to table, and it is used, as in England, as a pot herb and garnish. The wild variety (*Fenouil amer*) is rank and bitterish. It is much cultivated in Italy, and in the south of France about Nîmes.

Characters.—*Root* perennial. *Stem* somewhat compressed at the base, erect, branched, 3 to 5 feet high. *Leaves* much compounded, and cut into fringe-like segments. *Umbels* with 6 to 8 rays. *Fruit* oblong-cylindrical, about $\frac{4}{10}$ inch long and $\frac{1}{10}$ broad.

1. **Fœniculi fructus,** *P.B.* *Fennel Fruit.*

The ripe fruit imported from Malta.

Characters and Constituents.—About 3 lines long and 1 broad; elliptical, slightly curved, beaked, having eight pale-brown longitudinal ribs, the two lateral being double; taste and odour aromatic.

The fruit yields from 3 to 4 per cent. of *volatile oil*, which is composed of *anethol* or *anise-camphor* $C_{10}H_{12}O$, and a mobile oil isomeric with oil of turpentine. Anethol exists in both a fluid and crystalline form. The former distills at 437°, and may be thus separated; the latter is deposited on exposing the crude oil to a low temperature (see anise-camphor below): the crystals fuse between 60° and 70°, and, after long keeping, permanently assume the fluid form.

Three varieties of oil of fennel are met with—*oil of sweet fennel*, which has a sweet taste, and is most highly esteemed; *oil of bitter fennel*, prepared in the south of France, from the wild or bitter fennel, —it is distilled from the whole plant, and has a bitterish taste; and *Saxon oil of fennel*, which resembles the sweet oil.

Besides the essential oil, fennel fruit contains sugar and about 12 cent. of fixed oil.

Action and Uses.—Those of caraway, anise, and dill.

2. **Aqua Fœniculi,** *P.B.* *Fennel Water.*

Prepared in the same manner as Aqua carui, and using the same proportions of fruit and water.

PIMPINELLA ANISUM, *Linn.* Anise.

This annual, the ’Ανῖσον of the Greeks, is a native of Egypt and the Grecian Archipelago, and was very early known to the ancients. It is cultivated in the warmer regions of the globe, but the fruit does not ripen well in England.

Characters.—Stem about 1 foot high, smooth. *Radical leaves* heart-shaped, rather roundish, lobed, incised; stem leaves biternate; segments linear, lanceolate, rather wedge-shaped, acuminate. *Umbels* on long stalks, many-rayed, without involucres. *Flowers* small, white. *Calyx* obsolete. *Petals* obcordate, with an inflexed point. *Fruit* ovate, 1½ line long, covered with a few scattered hairs. *Carpels* with 5 filiform equal ridges. Interstices with 3 or more *vittæ.* *Stylopodium* tumid. *Styles* of the fruit recurved.—*Nees and Eberm.* 275; *Woodv. Med. Bot.* pl. 180.

1. **Fructus Anisi.** *Aniseed.*

Characters and Constituents.—Fruit nearly cylindrical, about $\frac{2}{10}$ inch long, didymous, the two carpels being nearly separated, with a short stalk and terminated by the short styles. Each carpel is furnished with 10 ridges. In transverse section from 25 to 30 oil ducts or vittæ are seen, those (4 or 6) on the commissure being the largest. The fruit is whitish-brown, like conium fruit, than which it is longer and not so plump, and the outer surface is rough with short hairs, and it has a sweet aromatic taste.

This fruit yields about 2 per cent. of colourless *volatile oil*, of sp. gr. 0·98 of a very sweet, warm, aromatic taste, and the pleasant odour of aniseed.

Between 50° and 60° it congeals into a dense radiated mass of pure white crystals. By pressure between folds of blotting paper a fluid portion, forming $\frac{1}{5}$ of the whole, may be separated. This is the unoxydised part of the oil; it is isomeric with oil of turpentine. The remaining solid or oxydised portion is *anethol* or *anise-camphor*, $C_{10}H_{12}O$. It is deposited in crystals from hot alcohol; fuses at 64°·4, boils at 431°·6, and has the sp. gr. 1·014. It readily forms substitution-products with chlorine and bromine. Under the influence of dilute nitric acid, oil of anise is converted into oxalic and anisic acid, and anisyl hydrate, $C_8H_7O_2,H$, which is homologous with oil of meadow sweet (see p. 415), and has the odour of new hay or the Tonquin bean. When the substance is treated with alcoholic solution of potash, it is converted into anisylic alcohol, C_8H_9O,HO, and anisic acid, $HC_8H_7O_2O$. The latter is isomeric with methyl-salicylate, and may be prepared synthetically. The seed yields about 3 per cent. of fixed oil.

2. **Oleum Anisi,** *P.B.* *Oil of Anise.*

The oil distilled in Europe from the fruit above described, and the oil distilled from the fruit of *Illicium anisatum* (which see).

Anethol, the chief constituent of oil of anise, exists in several plants besides the two just mentioned and fennel; thus it pervades all parts of *Myrrhis odorata* except the fruit, which is free from volatile oil, and is a constituent of *Artemisia Dracunculus* or Tarragon.

Characters.—Colourless or pale-yellow, with the odour of anise and a warm sweetish taste. Concretes at 50° (proving the absence of other volatile or fixed oils). The *constituents* are described above.

Action and Uses.—Those of caraway, fennel, and dill. It is like the other essential oils, slightly expectorant, and in the form of lozenge is a favourite remedy for coughs.

Pharmaceutical Uses.—A constituent of Tinctura comphoræ composita, T. opii ammoniata, and the following:—

2. **Essentia Anisi**, *P.B.* *Essence of Anise.*

A mixture of 1 volume of *the volatile oil* and 4 volumes of *rectified spirit.*

Dose.—10 to 20 minims as an aromatic stimulant or carminative.

CUMINUM CYMINUM, *Linn.* Cumin.

This small annual, the *Kumoon* of the Arabs, is a native of the regions of the Upper Nile, whence it was very early conveyed to the shores of the Mediterranean, to Arabia, and India, and was made known to the Greeks from Egypt. It is extensively cultivated in the East, and in the south of Europe. England is supplied from Sicily, Malta, and Mogadore.

Characters.—Annual, from 1 to 2 feet high. *Leaves* much-divided. *Segments* long and setaceous. *Umbels,* both general and partial, from 3–5 rayed, with involucres, of 2–4 simple or divided leaves. *Involucels* halved, of 2–4 leaves, finally reflexed, and exceeding in length the pubescent fruit. *Flowers* white or pink. *Calyx* with 5 lanceolate, setaceous, permanent teeth. *Petals* oblong, emarginate, with an inflexed point. *Fruit* laterally compressed. *Carpels* with 5 primary filiform minutely muricated ridges; 4 secondary hairy ones; *channels* oblong, striated, minutely aculeate under the secondary ridges, with 1 *vitta* in each, and 2 in the commissure.—*Esenb. and Eberm.* 288.

Characters and Constituents.—Cumin fruits are about $\frac{1}{4}$ inch long and $\frac{1}{10}$ broad, of a light-brown colour. In aroma they somewhat resemble caraway; the taste is warm, bitterish, and aromatic, but not so agreeable as anise. They yield $2\frac{1}{2}$ per cent. of *volatile oil,* 7·7 of *fixed oil,* 13 of resin, 8 of mucilage and gum, and 15 per cent. of albumin.

The aromatic properties of the fruit are due to the volatile oil; it is limpid, of a pale yellow colour, and sp. gr. 0·945. It is composed of a mixture of about equal parts of *cymol* or *cymene,* $C_{10}H_{14}$, and *cuminol* or *cuminaldehyd,* $C_{10}H_{12}O$. Cymol is a fluid hydrocarbon, of sp. gr. ·867, and boiling point 350°; in odour it resembles lemons. It is found in oil of thyme (see p. 474), is one of the products of the distillation of coal tar, and may also be obtained by distilling camphor with phosphoric anhydride. Oil of turpentine is hydride of cymol, and Oppenheim has transformed terpin (see p. 406) into cymol. Cuminol is isomeric with anethol; it has the taste and odour of cumin; sp. gr. ·972, and boils at 428°. Under the influence of nitric acid and other oxydising agents it is converted into cuminic acid, $HC_{10}H_{11}O_2$, which crystallises in colourless plates, and evolves an odour resembling that of the bug (*Cimex lenticularis*). Heated with alcoholic solution of potash, cuminol is converted into cuminic alcohol, $C_{10}H_{14}O$, an aromatic oily liquid of burning taste, which is isomeric with the oxydised constituent of oil of thyme.

Action and Uses.—Cumin is carminative like the other umbelliferous fruits. It is one of the principal constituents of curry powder.

AMMI COPTICUM, *Linn.* Ajowan.

This annual (the *Ptychotis Coptica* of Decand.) is cultivated largely in India, where it has been used from a remote period, and is known as *Ajvān* or *Omam.* It is also cultivated as a condiment in Persia and in Egypt.

Characters and Constituents.—The fruits (ajava seeds) resemble those of parsley; they are greyish-brown, rough from the presence of minute tubercles; each carpel has five prominent ridges, the dark-brown intervening ridges enclosing a single vitta, and there are two others on the commissure. The bruised fruits exhale a strong odour of thyme, and have a biting aromatic taste. They yield from 5 to 6 per cent. of aromatic volatile oil of sp. gr. ·896, which contains about 35 per cent. of *thymol* (see p. 474). When the oil is exposed to the air, this is deposited in fine tubular crystals. It is sold in the bazaars of India under the name of *Ajwain-ka-phul* or *flowers of Ajwain.*

Action and Uses.—A stimulant carminative. The distilled water is an article of the Indian Pharmacopœia; it is employed for the relief of colic, and as a pleasant vehicle for nauseous medicines. The volatile oil resembles that of thyme, and may be substituted for it.

PETROSELINUM SATIVUM, *Hoffm.* Parsley.

The fruit of the common parsley yields an aromatic *volatile oil* resembling that of the fruits of other umbelliferous plants, and a neutral non-nitrogenised body, termed by the discoverers, MM. Joret and Homolle, *Apiol.* They obtained it by treating the alcoholic extract with æther, in which the assiol is soluble. It is a pale yellow oily liquid, of sp. gr. 1·078, having a peculiar odour and very disagreeable taste. It is non-volatile, insoluble in water, but soluble in alcohol, æther, and chloroform.

Action and Uses.—Apiol produces symptoms resembling those which attend the action of quinia; thus 15 minims cause mental excitation similar to that induced by a large dose of strong coffee; and from 30 to 60 grains produce vertigo, with slight delirium, ringing in the ears, and severe frontal headache. The inference from these observations, that apiol would be beneficial in intermittent fever and intermittent neuralgia, has to some extent been borne out by clinical experience, but its effects are neither so direct, so powerful, nor so permanent as quinia. MM. Joret and Homolle also recommend apiol in atonic amenorrhœa and dysmenorrhœa given for the week preceding the expected period.

Dose.—In amenorrhœa 3 grains twice a day, or in a single dose of 15 grains as in the treatment of ague. It must be given in capsules, on account of its disagreeable taste.

CORIANDRUM SATIVUM, *Linn.* Coriander.

This is the *Gad* of the Hebrews and the Κόϱιον, Κοϱίαννον, and Κοϱιάνδϱον of the Greeks, from κόϱις, a bug, in allusion to the offensive odour of the bruised fresh plant. It is indigenous to the countries about the Mediterranean and Euxine, and is cultivated throughout the East, and to a limited extent in England (the Eastern counties), where it is occasionally found wild.

Characters.—Annual, from 1 to 2 feet high, round, striated, smooth. *Leaves* bipinnate, cut; leaflets of the lowermost wedge-shaped, of the others divided into linear segments. *Calyx* of 5 teeth. *Petals* white, often with a tinge of pink, obcordate, with an inflexed lobe, the exterior ones radiant and bifid. *Fruit* globose. *Carpels* with the primary ridges obsolete, the 4 secondary ones prominent, keeled. Interstices without *vittæ*. Commissure with 2 vittæ. *Seed* excavated in the front, covered with a loose membrane.—*Woodv. Med. Bot.* pl. 181.

Coriander is esteemed for its fruit (seeds, as they are called) both in the East, where it is much employed as a condiment, and is one of the chief ingredients of curry powder. In Europe it is employed by confectioners and distillers.

1. Coriandri fructus, *P.B.* *Coriander Fruit.*

The dried ripe fruit, cultivated in Britain.

Characters and Constituents.—Globular, nearly as large as white pepper, slightly beaked (the projection being formed of the stylopodium and calycine teeth), finely ribbed, yellowish-brown. It is composed of the two adherent hemispherical carpels, and has an agreeable aromatic odour and flavour. When unripe the odour is offensive. The fruit yields about ½ per cent. of *volatile oil*, on which the aroma depends, and 13 per cent. of fixed oil.

Action.—An agreeable stimulant and carminative. Used by cooks and gin distillers.

Pharmaceutical Uses.—Coriander fruit is a constituent of Confectio sennæ, Mistura gentianæ, Syrupus rhei, Tinctura rhei, and T. sennæ.

2. Oleum Coriandri, *P.B.* *Oil of Coriander.* $C_{10}H_{18}O$.

The volatile oil distilled in Britain from coriander fruit.

Characters and Composition.—Limpid, yellowish, having the odour of coriander, and the composition given above being isomeric with borneol (see Dryobalanops). By the abstraction of a molecule of water, it is converted into an oil, having the composition $C_{10}H_{16}$, and an offensive odour.

Pharmaceutical Use.—An ingredient of Syrupus sennæ.

ANETHUM GRAVEOLENS, *Linn.* Dill.

This plant is a native of countries surrounding the Mediterranean and of India. It is the 'Ανηθον of Dioscorides, and was familiar to the ancients. According to Prior, the English name dill is derived from the Norse, *dilla*, to lull, in allusion to its carminative properties.

Characters.—Annual, 1 to 2 feet high, every part smooth and glaucous, stem finely striated. *Leaves* tripinnated, with fine capillary segments like those of fennel, petioles broad and sheathing at the base. *Umbels* long-stalked, without general or partial involucres. *Calyx* obsolete. *Petals* varnished, yellow, roundish, entire, involute. *Fruit* lenticular flat, of a bright brown colour on the rather convex back, surrounded by a pale membranous margin. *Carpels* with equidistant filiform ridges, the 3 dorsal acutely keeled, the 2 lateral less distinct and passing into the margin. *Vittæ* broad, solitary, filling the whole channels, 2 on the commissure—*Woodv. Med. Bot.* pl. 159.

1. Anethi fructus, *P.B.* *Dill Fruit.*

The fruit of the plant above described, cultivated in England, or imported from Middle or Southern Europe.

Characters and Constituents.—Oval, flat (like parsnep fruit), about $\frac{1}{9}$ of an inch long and $\frac{1}{10}$ wide. The Indian fruit is a little narrower and more convex. The essential constituent is *volatile oil*, of which the fruit yields about 3 per cent. (see below).

Uses.—This fruit is employed as a condiment in India, but its use is confined to medicine in Europe.

2. Oleum Anethi, *P.B.* *Oil of Dill.*

The volatile oil distilled in Britain from the fruit.

Characters and Constituents.—Limpid, pale yellow, in odour and taste resembling caraway, but sweeter and more delicate. According to Gladstone, it is chiefly composed of a fluid hydrocarbon, *anethene*, isomeric with oil of turpentine, of sp. gr. ·846, boiling at 343°, and having the odour of lemons. The other constituent is an oxygenated oil, $C_{10}H_{14}O$, identical with *carvol* (see p. 577), having the same odour, and the sp. gr. ·956.

3. Aqua Anethi, *P.B.* *Dill Water.*

Prepared as directed for Aqua carui, using the same proportions of water and fruit.

Action and Uses.—A pleasant aromatic carminative. It is employed to relieve flatulence in infants, and as a vehicle for other medicines.

ARCHANGELICA OFFICINALIS, *Hoffm.* Garden Angelica.

This plant has long been employed in medicine. It is a doubtful native of this country.

Characters.—Biennial. *Root* large, pungently aromatic. *Stem* 3 or 5 feet high, hollow, striated, rather glaucous. Foliage, stalks, and even flowers of a bright glaucous-green. *Leaves* 2 or 3 feet wide, bipinnated or biternate. *Leaflets* ovate, lanceolate, sharply and closely serrated, all sessile, partly decurrent, terminal one trifid. *Petioles* much dilated at the base. *Umbels* terminal, globular, with dense secondary umbels. *Involucre* of 2 or 3 linear bracts, secondary one of about 8 linear-lanceolate bracts. *Calyx* minutely 5-toothed. *Petals* ovate, entire, acuminate, incurved. *Fruit* nucleated. *Carpels* or half-fruits with 3 dorsal thick-keeled and 2 marginal corky ridges, the latter dilated into broad wings. Interstices without *vittæ*. *Seed* free, with numerous vittæ. *Habitat*, watery places in the northern parts of Europe.—*Eng. Bot.* t. 2561.

The whole plant when bruised diffuses a strong and rather grateful odour. The root, when wounded in the spring, exudes an odorous yellow juice: when dried, the root is wrinkled, of a greyish-brown externally, and white internally; it has a warm and bitterish taste. The stem and leaf stalks, cut in May, when they are tender, are made into a preserve with sugar. The fruits have the same odour and taste, depending on the presence of *volatile oil*. The other ingredients of the root are resin, bitter extractive, gum, starch, water, and woody fibre.

Action. Uses.—Aromatic, stimulant, and stomachic. An infusion of the root or fruit may be given.

CONIUM MACULATUM, *Linn.* Hemlock.

This is the Κώνειον of the Greeks and the *Cicuta** of the Romans. The objection that their descriptions of the plant are insufficient to distinguish it from other Umbelliferæ, applies to accounts of other medicinal plants, even in comparatively modern works. Hemlock is the *shokran* of the Arabs, who give *chunium* and *kunion* as its Greek name, and give *bunj-roomee,* or Turkish *bunj*, as another name. The name *bunj* is applied to Henbane, while Datura is *bunj-dushtee.* Hemlock was reintroduced into practice by Störck.

Characters.—*Root* biennial, fusiform, whitish, a little fleshy, and often 2 feet long, and an inch in diameter at the crown. *Stems* 2 to 6 feet high, erect, round, smooth, spotted with dull-coloured purple spots. *Leaves* large, shining, of a deep-green colour, tripinnate, on long furrowed petioles, sheathing at the base. *Leaflets* lanceolate, pinnatifid, with the lower lobes incised, the others toothed. *Umbels* numerous, terminal, composed of many general as well as partial rays; general *involucre* of from 3 to 7 leaflets, ovate, cuspidate with membranous edges, partial involucre of 3 leaflets on one side, ovate lanceolate, shorter than the umbels. *Calyx* obsolete. *Petals* 5, white, obcordate with inflexed apices. *Stamens* 5. *Styles* spreading. *Fruit* ovate, compressed laterally. *Carpels* with 5 prominent, equal, undulated, primary ridges, of which the lateral ones are marginal. Channels with many striæ, but no vittæ.—Hedges and waste places throughout Europe; found in Greece by Sibthorp, in Cashmere by Falconer. Flowers in June and July. Fruit ripe in August and September.—*Flor. Lond.* fasc. ii. pl. 17.

All parts of the hemlock are pervaded by active principle, but it is chiefly contained in the leaves and fruit. I have examined the root dug up in January, just as the leaves are beginning to spring, with the following results :—It yielded about 56 per cent. of juice, of sp. gr. 1·0228, of acid reaction, a carrot odour, and a sweet carrot taste, and contained albumin, abundance of sugar, chlorine and phosphoric acid and a trace of sulphuric acid, combined with potassium, sodium, calcium, and magnesium. A fluid ounce of crude juice yielded 20 grains of extract, which left 1·3 grain of ash.

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* Hemlock must not, from the similarity of name, be confounded with *Cicuta maculata*. *Cicuta virosa* occurs in Cashmere, where it is called *Zehr-googul,* or poison-turnip. Persian, *Salep-e-Shaitan,* or Devil's Salep.

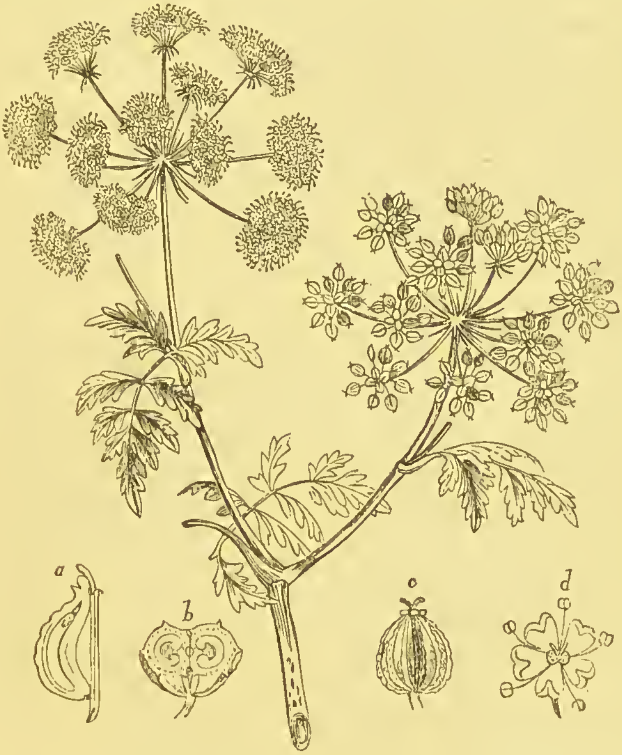

Fig. 94.—*Conium maculatum.* *d*, flower; *c*, fruit; *b*, transverse- and *a*, vertical section of fruit.

Compared with the other parts of the plant, the root contains only a very small proportion of conia. It also contains a bitter resin, and the two neutral bodies which I have described under the names, *rhizoconine* and *rhizoconylene* (see "Old Veget. Neur.").

1. **Conii folia**, *P.B.* *Hemlock leaves.*

The *fresh leaves* and *young branches;* also the *leaves* separated from the branches and carefully *dried*, gathered from wild British plants when the fruit is beginning to form.

Characters and Constituents.—Fresh leaves decompound, smooth, arising from a smooth stem, with dark purple spots; dried leaves of a full green colour and characteristic odour. The leaf rubbed with solution of potash gives out strongly the odour of conia.

Hemlock leaves have the same active constituents as the fruit (see below), but in much smaller quantity, and this is partially dissipated by drying, and ultimately lost altogether. The leaves contain a large quantity of a very bitter and nauseous oleo-resin. According to Crichton, they yield 12·8 per cent. of ash, consisting chiefly of chloride of sodium and phosphate of lime.

I have been enabled, by the kindness of Mr Henry Deane of Clapham, to estimate physiologically the quantity of conia contained in the fresh leaf and in the leaf immediately after it is carefully dried by exposure to the air. The fresh leaves are reduced to ¼ of their weight in course of drying, and 1 ounce of the dry leaf therefore represents 4 ounces of the fresh. From comparative observations (see *Practitioner*, 1870, p. 335, *et seq.*), I estimate that the fresh leaf contains about ¼ per cent. of conia at most, and that one-half of this is lost in the process of drying. The dried leaf, therefore, contains twice as much conia as an equal weight of the fresh. This, however, is only true of the *recently* dried leaf, for by keeping it rapidly loses conia, and at the end of a year contains merely a trace.

Adulteration.—The leaves of several species of *Chærophyllum*, especially the common species *C. Anthriscus*, and those of *Æthusa Cynapium* or Fool's parsley, are liable to be confounded with hemlock leaves. The leaves of the common species of Chærophyllum are easily distinguished by their pubescence. Those of Fool's parsley are as bright and smooth as hemlock leaves, but the incisions of the leaflets are not acute, like those of hemlock, and the entire leaf is not a third of the size of a hemlock leaf. The development of the odour of conia on the addition of solution of potash is of course a conclusive test.

Pharmaceutical Uses.—The dried leaves are a constituent of the Cataplasma conii; and the fresh leaves are the source of the Succus and Extract.

2. Conii Fructus. *Hemlock Fruit.*

The dried fruit.

It has been conclusively shown by Sir R. Christison, Dr Manlius Smith, and myself, that the immature fruit contains a larger amount of conia than the dry; and I have further proved that the fruit undergoes such rapid deterioration by keeping, that the commercial article which is chiefly derived from the Continent is almost destitute of the active principle.

The fruits contain the largest amount of conia just before they come to maturity, that is when they have attained their full size, but are still soft and green. At this stage they should be collected, spread out in thin layers on porous paper, dried in a warm, shady room, at about the temperature of 80°, and then preserved in a dry place in well-closed tin canisters. With these precautions they will retain their virtues unimpaired for more than a year. They evolve a powerful hemlock odour and taste, and being thinner and darker than the ripe fruits, more closely resemble caraway fruits.

Characters and Constituents.—Broadly ovate, about $\frac{1}{8}$ inch long, compressed laterally. Carpels (or half fruits) with five waved or crenated ridges, of the colour and size of aniseed, but shorter. Reduced to powder and rubbed with solution of potash, they give out strongly the odour of conia.

The ripe fruit contains a variable amount of *conia*, $C_8H_{15}N = 125$ but never, it appears, more than $\frac{4}{5}$ per cent.; *conhydria* $C_8H_{17}NO$, *Methyl-conia* $C_8H_{14}(CH_3)N$, a third alkaloid apparently composed of $C_7H_{13}N$, and a volatile oil. The active properties depend on conia.

Pharmaceutical Uses.—The preparation of Tinctura conii.

3. **Conia** (Conylia, Coniine, or Conine),

Is a colourless, volatile, oily liquid, of sp. gr, 0·89, boiling at 339°·8, and having a disagreeable penetrating animal odour and biting taste. It is slightly soluble in water, and to a greater extent in cold than in hot; it is freely soluble in alcohol and in æther; and being strongly alkaline, neutralises the strongest acids completely, and precipitates many of the metallic oxydes from their salts, but its salts are either uncrystallisable or very deliquescent. Exposed to the air it rapidly absorbs oxygen and is converted into a brown semi-solid substance. When acted upon by iodide and methyl or of æthyl, an atom of hydrogen is displaced and replaced by one of methyl or æthyl. Conia indeed contains the hydro-carbon, conylene C_8H_{14}, which has been separated by Wertheim, and the relationship of the above mentioned compounds may be thus represented:—

Conia,	$C_8H_{15}N$	=	$H,(C_8H_{14})N$
Conhydria,	$C_8H_{17}NO$	=	$H,(C_8H_{14})N,H_2O$
Methyl-conia,	$C_9H_{17}N$	=	$CH_3(C_8H_{14})N.$
Ethyl-conia,	$C_{10}H_{19}N$	=	$C_2H_5(C_8H_{14})N.$

Conhydria is strongly alkaline, and may be sublimed in colourless prisms. When heated with phosphoric anhydride it is converted into conia and water. Conia is usually obtained by distilling the plant with an aqueous solution of potash, but as the alkaloid is partially decomposed in this crude process, it is not fitted for the detection of minute quantities of the alkaloid. The following plan may then be adopted :—Exhaust the solid containing the conia with water containing 1 per cent. of sulphuric acid ; or acidulate the suspected fluid with sulphuric acid. Evaporate the fluid spread out in a thin layer in a current of warm air to a syrupy consistence, and mix it with an equal bulk of solution of potash in a long burette, and agitate the mixture with an equal bulk of æther ; draw off the fluid, and wash it again with a fresh portion of æther. On distilling the separated portions of æther by a warm-water bath, the conia, more or less pure, remains. The impure akaloid is shaken with a little water acidulated with sulphuric acid, by which means it is separated from oily or resinous matter. The alkaloid is again set free by excess of caustic potash, and removed from the mixture as before by shaking with æther. The isolation being completed by the gentle evaporation of the æther.

Action.—The active properties of hemlock are exclusively due to conia: they are therefore appropriately considered in this place.

A moderate dose of hemlock (3 to 6 fluid drachms of the succus) produces, in the course of thirty or forty minutes, a slight impairment of motor power, inducing a sense of fatigue when walking up hill; and if the body be supported on one leg, this will be weak and shaky: the adaptation of the eye becomes so sluggish, that whenever it is shifted to a nearer or more distant object, a haze or mist overspreads the field of vision, inducing a sense of giddiness, until the eye is again rested upon some object. This effect, combined with the impairment of voluntary power, induces an inclination to unsteadiness of gait, and the attention is strongly aroused to control the voluntary movements. These effects continue for about half an hour, and then disappear as suddenly as they came on, leaving the patient in the possession of the customary vigour. After larger doses the individual is suddenly overtaken, while walking, with a general tiredness and a special weakness of the knees, as if he had walked to the full extent of his powers; there is strange feeling of lightness and powerless of the legs, and a tendency to drop forward on the knees, associated with some giddiness and a feeling of heaviness over the eyes. If the subject should be a delicate man; or a woman engaged in a sedentary occupation, she would be suddenly overwhelmed with a sense of swimming and muscular lethargy, and on attempting to rise from her chair, she would need to repeat and increase her effort twice or thrice before she succeeded; then she would be conscious of weakness of the legs, and on attempting to walk would reel, and perhaps fall. The visual effects are proportionally strong; the letters of the book she is reading, or the needle-work in which she is engaged, suddenly become confused, and on raising the eyes to a distant object, the field of vision is hazy and disordered, and objects appear double or multiple, overlapping and deranging each other. In woman, the muscular weakness is usually first perceptible in the upper extremities; and as the depression of motor power swiftly overwhelms them, she drops the child that may be in her arms, or the object she has in her hands. If the dose has been a sufficient one, she falls, and soon becomes incapable of voluntary movement, the limbs being flaccid like one in a state of complete alcoholic intoxication. There is complete ptosis, and the pupils are moderately dilated. Neither the pulse (apart from the apprehension caused by the sudden invasion of these symptoms), the respiration, nor the intelligence are in the least affected. The patient converses calmly, and expresses herself as being extremely comfortable. There is no direct hypnosis, but the complete state of muscular repose and ptosis by which the attention to external objects is excluded, strongly predispose to slumber. I have sometimes induced these effects in women, and frequently in young children, producing complete relaxation of the voluntary muscular system, but without affecting speech or deglutition; but in strong men such a condition is never, to my knowledge, induced without a very decided implication of the tongue and gullet,—the muscles of mastication are so nearly paralysed, that it is with some difficulty that the patient can bite through a piece of soft bread; the speech is slow and thick, from relaxation of the tongue; the voice is low and gruff, from corresponding relaxation of the laryngeal muscles, and deglutition is either very slowly performed or impossible. Such are the full effects of conium, or *coneism*, as I have called them, when the drug is carried to the fullest extent. Beyond this it is hardly safe to go; for we already trench on the involuntary acts: the respiration indeed is not appreciably affected, but when the coneism has passed off, sighing and a feeling of aching or weary oppression around the margin of the ribs is complained of, indicating a temporary depression of the respiratory function and sluggish action of the diaphragm.

If larger doses be given there is complete paralysis, with loss of speech; the respiratory function is gradually depressed, and, ultimately failing altogether, death results from asphyxia. The mind and senses remain intact to the last.

Such are the effects of hemlock, and they are simply due to paralysis of the centres of motion—first, of the corpora striata, and afterwards of the centres of motion in the cord. They are the same for all animals. Arguing from experiments on frogs, some experimenters have concluded that the muscular paralysis is due to a direct action of the drug on the peripheral extremities or "end organs" of the motor nerves, because they find—*firstly*, that after conium poisoning galvanism of the nerves fails to induce contraction in the muscles; *secondly*, if the poison be prevented access to a given set of muscles by ligature of the artery or arteries supplying them, irritation of the nerves going to these muscles produces contraction in them; *thirdly*, if all the tissues of the leg of a frog excepting only the main nerve be severed, and the animal be then poisoned by conia—when palsy is complete in all the rest of the body, and contraction of the muscles cannot be induced by galvanising the motor nerves—the muscles of the severed leg respond not only to electrical irritation of its nerve, but also to stimuli applied to distant parts of the body (Pelvette and Martin-Damourette). Those who interfere thus rudely with the intricate mechanism of the animal frame should be careful to tell us the amount and value of the disturbances which their crude experiments introduce, and not, as they do, thoughtlessly assume that such disturbances do not exist. Thus, in reference to the experiment last-mentioned:—surgeons credit the knife with a stimulant action; and certainly those animals who are gifted with sensation do experience an unusual irritation in severed parts, and it might fairly be assumed that such direct and severe irritation in the severed nerves of a part would effectually antagonise a sedative influence on the nerve centres. Of course, if the centres of motion of the spinal cord as well as those in the brain were completely paralysed, no motion could be elicited in muscles under any circumstances; but so long as the animal breathes, the spinal cord is not wholly paralysed by the conium, and therefore irritation of the nerve of the severed limb (which of course contains efferent fibres), or of any portion of the skin, may be expected to produce reflex contractions in a limb, to the nerves of which the poison has been prevented access, and in which the effect of the poison on the nerve centres is antagonised by local irritation.

Further, Drs Davidson and Dyce Brown give evidence in support of the central action of conium. They find that after ligature of the femoral artery in the cat, the limb lost power under the influence of conia as rapidly as the others. From personal experience of the action of conium, and extensive observations of its effects in health and disease, I conclude that at first conium chiefly expends its power on the corpora striata, and in many individuals to the extent of producing complete paralysis of all the voluntary muscles before its action is at all manifest on the spinal cord; that the motor centres of this part of the nervous system are the last to be affected, and that the fatal result is due to obliteration of the function of these centres. It may perhaps be granted that the conductivity of the motor nerves is diminished in the same order. Fatal doses of conium, of course, diminish the temperature of the body by depressing the respiratory function.

Conia appears to undergo rapid decomposition in the blood; for I have failed to detect any trace of it in this fluid, in the urine, or in any of the other fluids of the body.

Medicinal Uses.—Since conium acts as a sedative, and in sufficient doses as a paralyser to the centres of motion, its remedial effects are obvious; but it must be remembered that its influence on the centres of involuntary movement is much weaker than that on the corpora striata, and that a decided sedative action on the spinal cord can only be induced by very large doses. Since the action of conium is directly antagonistic to that of *strychnia*, they may be regarded as direct antidotes. For the same reason conium is the most appropriate remedy in *tetanus*. My friend Mr F. Mavor, of Park Street, has found it most efficacious in the treatment of this disease in the horse; and in the only case in which I have been able to use it in the human subject the relaxing effect was complete. The treatment, however, was adopted too late to prevent a fatal result in this case; for the patient had been sinking for some days with mortification of both feet. In *chorea* I have found conium more beneficial than any other remedy; and when the disease is due, as it commonly is, to idiopathic irritation of the corpora striata, the beneficial effects are most marked. When the nervous affection is due to rheumatic irritation, the remedial effects of conium are less obvious, and this drug should be used only as an adjunct to the treatment appropriate for rheumatism. But it is in the *undue excitement of the motor centres* *arising from dentition* that I have found hemlock most valuable. In these cases it acts as opium does on the unquiet brain, soothing the excited centres to rest, and regulating and strengthening them by repose. In *epilepsy from dentition*, conium is equally serviceable, but in emotional or peripheral epilepsies conium is useless. In *cramp* or *spasm* of the voluntary muscles. as in spasmodic torticollis, I have found conium give relief; and if the disease be not of long standing it will, if given in sufficient doses and for a proper time, effect a cure. In very chronic cases, where the spasmodic movements have become habitual, it gives relief. So also in the early stage of *paralysis agitans*, when only one limb is affected, and the body is not as yet debilitated by the disease, conium brings relief. In *spasms of the orbicularis* which attends keratitis, and sometimes cataract, hemlock is invaluable, and completely excludes any necessity for incision of this muscle.

In *laryngismus stridulus* and other spasmodic affections of the larynx, and in *spasm of the gullet*, hemlock is the appropriate remedy, and the patient should be brought well under its influence before any attempt be made to remove foreign bodies from the gullet or stomach. In Störck's time hemlock was lauded as a remedy for *cancer* and *scrofula*, but since it has no influence over the nutritive functions, it cannot possibly control constitutional diseases; still, by virtue of its powerfully antispasmodic action, it may give much relief in cancer when a sphincter is involved in the disease. The drug early obtained a reputation for depressing the *sexual function*, and where there is undue excitement it certainly does exercise a very beneficial effect.

In acute mania, associated as it so often is with an exaggerated development of muscular power, or undue excitement of the motor centres, conium is invaluable. It may often be advantageously combined with opium.

Dose.—Whatever may be the affection for which hemlock is prescribed, the dose must be sufficient to produce coneism to a greater or less extent. In most cases some drooping of the eyelids, with relaxation of the orbicularis, giving them a swollen appearance, sluggish movement of the eyeball, laziness of vision, with giddiness and weakness of the knees, are the indications of moderate coneism and of a proper effect. A dose which does not readily induce some or all of these symptoms cannot be expected to do good in the disorders for which the remedy is suited.

Further, the dose of conium must be proportionate not to the muscular strength, but to the motor activity. A restless child will therefore require a much larger dose than a sluggish adult. Persons in advanced life, and with a damaged respiratory function, are those most readily affected by hemlock.

Conia in my hands has not proved a satisfactory drug, for it is variable both in strength and action. It is very prone to change, and should therefore be converted by the manufacturer, as soon as it is isolated, into a solution of acetate or sulphate. Even in this case there will be considerable variation in strength, for it would appear to be partially changed into methyl-conia in the process of distillation. This may, perhaps, be obviated by extracting it without heat, as in the process above given. Dr J. Wilkie Burman, who has extensively employed conia hypodermically, found some specimens produce in his own person exceptional and dangerous symptoms (*West Riding Lun. Asy. Rep.* vol. ii). For these reasons it is necessary to find the value of each new sample of conia, and the dose at first should not exceed $\frac{1}{10}$ of a minim, given subcutaneously, and be increased until the symptoms of coneism above mentioned are induced. To produce decided coneism in a strong active man, from $\frac{1}{4}$ to $\frac{1}{2}$ minim is usually required, and full effects may be expected to follow 1 minim. Given by the stomach, we may commence with $\frac{1}{2}$ minim. Conia is a powerful local irritant, and whether administered by the stomach or skin, should always be previously neutralised by acetic or sulphuric acid.

The subcutaneous use of conia is indicated in tetanus, strychnia poisoning, and in acute mania. Coneism is developed within fifteen minutes, and, after a moderate dose, persists for about 1½ hour. When the patient has been brought fully under the influence of the drug by one or two doses, then its further exhibition must be carefully determined by the state of the muscles (and those of mastication may be taken as the guide) and the extent of the respiratory movements. When the muscles are relaxed and the respirations are of only very moderate extent, and do not exceed 12 in the minute, an interval of two or three hours should elapse before another dose is given.

Treatment of Poisoning by Hemlock.—Diffusible stimulants, forced exercise, artificial respiration, and warmth to the extremities.

4. **Succus Conii,** *P.B.* *Hemlock Juice.*

Prepared from the fresh leaves in the mannner and proportions directed for henbane juice.

This preparation varies according to season and locality; in fact, it is dependent on the succulency of the plant. A strong juice has a dark, reddish-brown colour, a high specific gravity—1012 to 1016, and, as compared with a lighter-coloured juice, it may be twice or three times stronger. Much of the succus is prepared from the leaves and shoots of the plant before the flower stem is developed. When the juice is prepared from plants in which the fruit is beginning to form according to the directions of the Pharmacopœia, a pleasant and efficient drug for ordinary use is obtained; but since the maximum dose of this for a man of ordinary strength is between 2 and 4 fluid ounces, it is too weak a preparation for many cases.

Dose.—From 2 fluid drachms to 2 fluid ounces. In the treatment of chorea in young children I begin with 2 drachms, and increase it daily by one or two drachms until the proper degree of coneism is induced. In adults I usually commence with a fluid ounce. When an efficient dose is reached, it is usually unnecessary to repeat it for twelve or twenty-four hours. Some children under six years of age will take a fluid ounce twice in the twenty-four hours. The effects usually appear about half an hour after taking the dose, and, according to the amount, continue for one to three hours, and then disappear.

6. **Tinctura Conii**, *P.B.* *Tincture of Hemlock.*

Prepared by exhausting 2½ ounces of *bruised hemlock fruit* with 1 pint of *proof spirit* in the manner directed for tincture of aconite and obtaining 1 pint of the tincture.

This is an useless preparation. I have taken 2 fluid ounces of it at a dose without any other effect than that produced by an equivalent quantity of alcohol. According to Geiger, 1 ounce of ripe fruit yields only 3 grains of conia; and assuming the fruit to be in no degree deteriorated by keeping, a pint of the tincture could, at most, contain only 7½ grains = 0·375 grain of conia in a fluid ounce —a quantity insufficient to produce slight coneism in a weakly person. Under the most favourable conditions, therefore, the quantity of fruit prescribed is not nearly sufficient. The following is offered in its stead:—

6. **Tinctura Conii fructus viridis.** *Tincture of the immature fruit of Hemlock.*

Prepared by exhausting 5 ounces of *dried immature fruit*, ground (see p. 586), or 8 ounces of the *undried immature fruit*, crushed, with 1 pint of *proof spirit*, and obtaining 1 pint of the tincture.

Dose.—2 to 8 fluid drachms = ¼ to 2 grains of conia, and always commencing with the smallest dose.

7. **Extractum Conii liquidum.** *Fluid Extract of Hemlock.*

Preparation.—Reduce 1 pint of the *tincture of the immature fruit*, previously mixed with 2 fluid drachms of *dilute sulphuric acid*, to 4½ fluid ounces by rapid distillation at a temperature not exceeding 212°. Set the product by for a fortnight, and then filter from deposited oleo-resin, and add ½ fluid ounce of *rectified spirit.*

The acid is added to prevent volatilisation of the conia. This preparation resembles the very efficient liquid extract so long prepared by Dr Squibb of New York from the immature fruit.

Dose.—½ to 2 fluid drachms, always commencing with the smallest dose.

8. **Extractum Conii**, *P.B.* *Extract of Hemlock.*

Prepared from the juice of the leaves and young branches in the manner directed for extract of henbane.

When prepared by vacuum apparatus from herb in the best condition, this extract, I find, does not contain more than 1 per cent. of conia; and if subjected to the long exposure required when vacuum pans are not used, as in the ordinary process, still less. From 40 to 80 grains of the best extract are required to produce moderate coneism. Hence this preparation, which has, according to some authors, effected wonderful cures, is practically inert. The preparation next following is offered as a substitute.

Pharmaceutical Uses.—A constituent of Pilula conii composita and Vapor coniæ.

9. Extractum Conii alcoholicum. *Alcoholic Extract of Hemlock.*

Preparation.—Rapidly distil off the spirit from the tincture of the immature fruit, evaporate to a syrupy consistence, and then add sufficient powdered liquorice (about $\frac{1}{3}$ part), and mix thoroughly, so that, when cold and after exposure to a moist air for twenty-four hours, it is of the proper consistence to form pills.

Without the use of the liquorice powder a bright yellowish-brown, brittle, but very deliquescent extract is obtained, from 3 to 5 grains of which produce moderate coneism. The addition of the liquorice powder obviates the difficulties which would result from its deliquescent properties, while it does not inconveniently dilute the extract.

Dose.—5 to 10 grains.

10. Vapor Coniæ, *P.B. Inhalation of Conia.*

Preparation.—Mix together 60 grains of *extract of hemlock*, 1 fluid drachm of *solution of potash*, and 10 fluid drachms of *water.*

The potash sets free a large quantity of ammonia, and, if the extract be exceptionally good, about half a grain of conia.

Use.—Put 20 minims (= nearly 0·002 grains of conia) of the mixture on a sponge, in a suitable apparatus, so that the vapour of hot water passing over it may be inhaled. Since the quantity of conia in the above form is too minute to relieve spasm, and that its sedative effects would be more than neutralised by the simultaneous evolution of ammonia, the following form is offered as a substitute: —Dissolve 1 grain of conia in $\frac{1}{2}$ fluid drachm of rectified spirit, and add it to a mixture of 1 fluid drachm of rectified spirit and $2\frac{1}{2}$ drachms of water. 20 minims contain $\frac{1}{12}$ of a grain of conia.

If the peripheral ends of nerves were alone affected by conium this would appear to be a direct way of relieving spasm of the bronchial tubes, but the prescription seems to imply that the local irritant action of conia has been overlooked.

11. Pilula Conii composita, *P.B. Compound Hemlock Pill.*

A mixture of 5 parts of *extract of conium* and 1 part of powdered *ipecacuanha*, as much *treacle* being used as is necessary to form a pill mass. When made with the alcoholic extract of conium, this pill is an useful antispasmodic expectorant, very serviceable for the relief of spasmodic cough, or the laryngeal spasm which attends tubercular or syphilitic disease of the part.

12. Cataplasma Conii, *P.B. Hemlock Poultice.*

Preparation.—Mix 1 ounce of *hemlock leaf in powder* with 3 ounces of *linseed meal*, and gradually add them to 10 fluid ounces of boiling water, with constant stirring.

1 ounce of the recently dry leaf is equivalent to 4 ounces of the

fresh leaf, and contains about 2 grains of conia, but the leaf usually employed contains only a trace of the alkaloid. The poultice may be used as a mild antispasmodic in affections of the larynx.

NARTHEX ASSAFŒTIDA, *Falconer.* Assafœtida.

Assafœtida, a product of Persia and Affghanistan, is mentioned in the ancient Sanscrit *Amera Cosha.* The ancients highly esteemed a gum-resin which the Romans called *Laser*, and the Greeks ὀπὸς Κυρηναϊκός, or the Cyreniac Juice, from being produced in that country. The plant σίλφιον yielding it was an umbellifer, and is represented on the coins of Cyrene. It has been discovered of late years, and named *Thapsia silphium.* This Laser had become scarce even in the time of Pliny, who, as well as Dioscorides, describes another kind as obtained from Persia, India, and Armenia, which was probably the same that was known to the Hindoos. Avicenna describes *hulteet* as of two kinds: one, of good odour, from Chiruana (Cyrene?); and the other fœtid, the present *Assafœtida.* The term *assa* is no doubt of Oriental origin, since it is applied to other gum-resins. (See Benzoin).

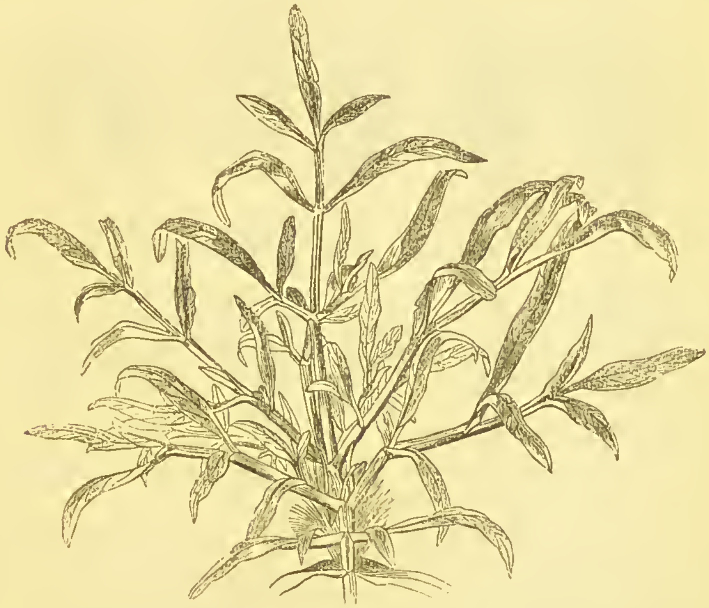

Fig. 95.—*Narthex Assafœtida*, Falc. Grown in the Botanic Gardens at Saharunpore.

Characters.—A gigantic herbaceous plant. *Stem* erect, 10 feet high, branched above. *Root* perennial, fusiform, 3 inches in diameter at the summit, abounding in a white, milky, fœtid alliaceous juice. *Leaves* 18 inches long, light-green, bipinnate, leaflets linear, obtuse, entire or sinuate; upper leaves destitute of laminæ, composed of large sheathing petioles. *Umbels* terminal compound; involucres, both general and partial, wanting; secondary umbels with very short rays aggregated into round pseudo-capitula. *Flowers* small, only a portion fertile. *Calyx* nearly obsolete, 5 minute points. *Stylopodia* urceolate and plicated, with a sinuous margin. *Styles* filiform, reflexed in the ripe fruit, rather short. *Fruit* from 7 to 15, ripening on the partial umbels, supported on short stalks. *Carpels* broadly elliptical, 5 to 6 lines long by 3 to 4 lines broad, flat, thin foliaceous, but somewhat convex in the middle, with a dilated border, generally unequal-sided, of a dark reddish-brown towards the centre, lighter towards the margin. *Ridges* 5; the 3 dorsal filiform, slightly crested towards their confluence at the apex; the lateral lost in the border, but distinctly seen on the commisure, and confluent with the middle nerve of the latter. The dilated border as wide as the space occupied by the 3 middle ridges. *Vittæ* in the dorsal furrows large and broad, usually solitary, but sometimes double or dichotomous, with a small branch, in the broadest side of the margin, turgid with a fœtid juice; vittæ of the commissure varying from 4 to 6, very unequal and variable; the outer often branched, and covering the border with a beautiful network of anastomosing ramifications. *Seed* flattened. *Carpophores* persistent, twice the length of the pedicles. *Habitat.*—Provinces of Khorassan and Laar in Persia, extending to the plains of Toorkostan on the Oxus, north of the Hindoo Khoosh Mountains, and across from Beloochistan through Candahar and other provinces of Affghanistan to the eastern side of the valley of the Indus.—*Falcon MS.; Assafœtida disgunensis,* Kæmpf., *Amœnit. Exot.* p. 535; *Edin. Roy. Soc. Trans.* vol. xxii. plates 20, 21.

FERULA ALLIACEA, Boiss (*Flora Orientalis*, ii., pl. 995), or *Angûsa,* exhales an intense alliaceous odour, and is probably a source of assafœtida.

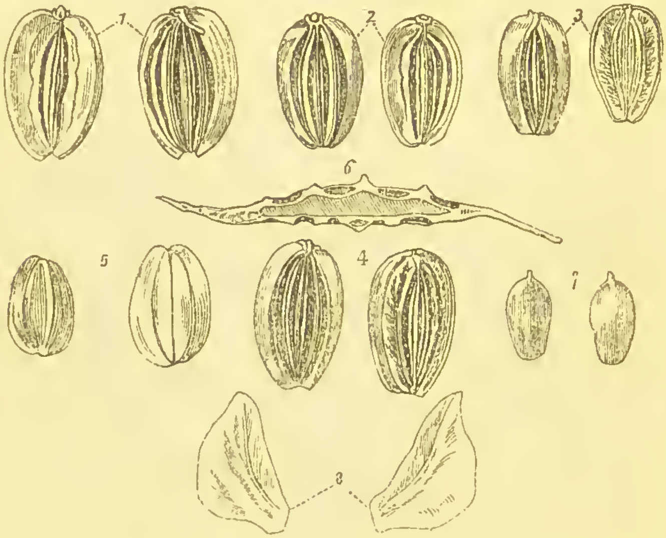

Fig. 96.—*Narthex Assafœtida.* 1–4 Carpels of the natural size. 5. Carpels in Kæmpfer's Herbarium, dorsal aspect. 6. Transverse section of carpels enlarged. 7. Seed natural size. 8. Two Petals of a barren flower enlarged.

The plant above described appears to be true *Assafœtida disgunensis*, or "Hingiseh" of Kæmpfer. No other botanist seems to have met with it since it was examined *in situ* by that excellent and careful observer a century and a half ago, until Dr Falconer discovered it in 1838 in the valley of Astore or Hasora, north of Kashmir.

Dr Falconer, after comparison of his materials with Kæmpfer's description and figures (*Amœn. Exot.* p. 537), and with his original specimens contained in the Banksian collection in the British Museum, found them, so far as a comparison could be instituted, to agree in every essential respect.

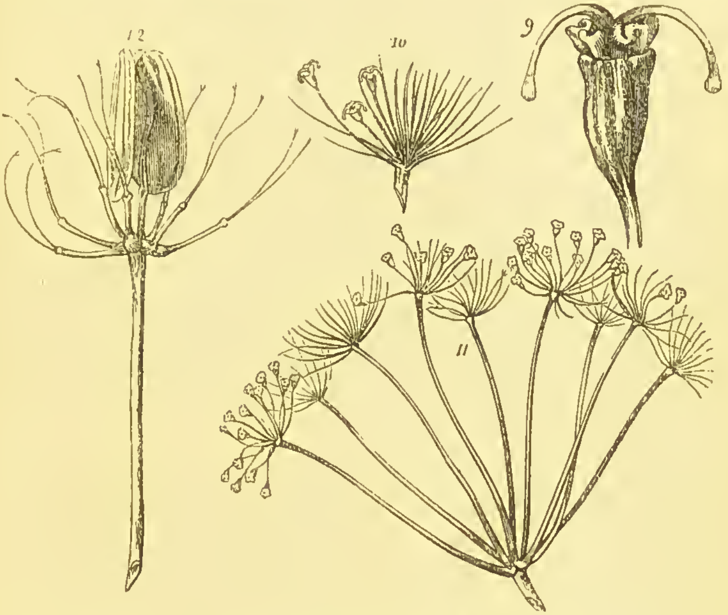

Fig. 97.—*Narthex Assafœtida*. 9. Ovary. Style and Stylopodium enlarged. 10. Partial Umbel, with fertile flowers. 11. Umbel of barren flowers. 12. Partial Umbel in fruit with persistent Carpophores.

Lindley, in his *Flora Medica*, p. 45, after an abridgement of Kæmpfer's description, states (it is not mentioned upon what evidence), the vittæ of the back to be "about 20 or 22, interrupted, anastomosing, and turgid with assafœtida: of the commissure 10." This account will apply to the fruit of a species of Ferula, but it is entirely at variance with the characters presented by the fruits of the plants observed by Kæmpfer in Persia, and by Dr Falconer in Astore.

Assafœtida is produced in the dry southern provinces of Persia, as in the mountains of Fars and of Beloochistan, but chiefly in Khorassan and Affghanistan; likewise to the north of the Hindoo Khoosh range of mountains, where it was found by Burnes, and also in Wood's expedition to the Oxus. Dr Falconer found it in Astore, introduced the plant into the Saharunpore Botanic Garden, as mentioned in Dr Royle's *Productive Resources of India*, p. 223, and has obtained from it a small quantity of assafœtida. He sent home numerous seeds, which were distributed from the India House to several gardens. Assafœtida is now cultivated in Affghanistan and the Punjaub. It is conveyed on camels into India across the Punjaub and Bhawulpore, and is sold in large quantities at the

Hudwar Fair. It is also conveyed down the Indus and by the Persian Gulf to Bombay.

M. Bushe, a late traveller, states that the mode of collecting assafœtida in Persia at the present day is exactly the same as that described by Kæmpfer 160 years ago. It is obtained by making incisions into or taking successive slices of the top of the root, and then collecting the produce, which is united in masses, and in this state is usually met with in commerce.

Besides the gum-resin, the fruit of *Narthex Assafœtida* is imported into India from Persia and Affghanistan, under the name of "Anjoodan," being the epithet applied to the seed of the "Heengseh," or "Hulteet," by Avicenna, also quoted by Kæmpfer, and used by the Indo-Persian and Arabic writers generally in describing the assafœtida plant. Another umbelliferous fruit, called Dooqoo (= *δαῦκος*?), which Falconer found to belong to a species of *Ferula*, is also imported with it, possibly as a substitute for "Anjoodan," which it closely resembles. The species of Ferula yielding this fruit may furnish some one of the obscurely-known gum-resins resembling assafœtida produced in Persia.

1. **Assafœtida**, *P.B.* *Assafœtida.*

A gum-resin obtained in Affghanistan and the Punjaub, by the incision from the living root of the plant above described.

Characters and Constituents.—In irregular masses, partly composed of tears, moist or dry. The colour of a freshly cut or broken piece is opaque-white, but gradually becomes purplish-pink. Taste bitter acrid; odour fœtid, alliaceous and persistent. It dissolves almost entirely in rectified spirit (absence of earthy or starchy impurities).

Assafœtida yields from 3 to 5 per cent. of *volatile oil*, and traces of *malic*, *acetic*, *formic*, and *valerianic acids*, and is otherwise composed of about 60 per cent. of *resin* and 40 of *gum*. The volatile oil is pale yellow, of a pungent and very repulsive odour of assafœtida, and a warm but not acrid taste; it contains from 20 to 25 per cent. of sulphur, and boils at 280°, with the evolution of sulphide of hydrogen; this also occurs when it is exposed to the air, and the oil acquires an acid reaction.

The resin is almost wholly soluble in æther and in chloroform, and contains *ferulaic acid*, $C_{10}H_{10}O_4$, which forms irridescent prisms, soluble in boiling water. It is homologous with eugetic acid. When fused with potash it is resolved into carbonic, oxalic, and the fatty acids; the resin yields with caustic potash resorcin, $C_6H_6O_2$, a white crystalline homologue of orcin (see p. 363); subjected to dry distillation, the resin yields oils of a green or purple tint, and about ¼ per cent. of *umbelliferone*, $C_9H_6C_3$, which is isomeric with quinone, and forms beautiful rhombic prisms, which are soluble in boiling water, in alcohol, and in æther, and may be distilled unchanged; but when fused with potash yields resorcin. The aqueous solution of umbelliferone displays on the addition of an alkali a brilliant blue fluorescence.

Action and Uses.—Stimulant, carminative and reputed to be emmenagogue. In the East it is chiefly used as a condiment instead of garlic. It is employed in medicine to relieve the flatulent distension which often accompanies hysteria, chorea, and epilepsy, and for the relief of flatulent colic.

Dose.—5 to 20 grains, in one of the following forms :—

2. **Enema Assafœtidæ**, *P.B.* *Assafœtida Enema.*

Prepared by rubbing 30 grains of *assafœtida* into an emulsion, with 4 fluid ounces of *water* added gradually.

Used to relieve flatulent distension of the colon.

3. **Tinctura Assafœtidæ**, *P.B.* *Tincture of Assafœtida.*

Preparation.—Macerate 2½ ounces of *assafœtida*, in small fragments, in 15 fluid ounces of *rectified spirit*, for seven days, with occasional agitation; then filter, and add sufficient rectified spirit to make 1 pint of the tincture.

Dose.—½ to 1 fluid drachm. It forms an emulsion with water, and may be employed to form the enema, 6 fluid drachms being mixed with 4 fluid ounces of mucilage of starch.

4. **Spiritus Ammoniæ fœtidus**, *P.B.* *Fœtid Spirit of Ammonia.* See p. 111.

This preparation contains the volatile oil of assafœtida above described, which must be regarded as its essential constituent.

Dose.—½ to 1 fluid drachm.

5. **Pilula Assafœtidæ composita**, *P.B.* *Compound Assafœtida Pill.*

Preparation.—Heat 2 ounces each of *assafœtida*, *galbanum*, and *myrrh*, and 1 ounce of *treacle* all together in a water bath, and stir the mass until it assumes an uniform consistence.

Dose.—5 to 20 grains.

6. **Pilula Aloes et Assafœtidæ**, *P.B.* *Aloes and Assafœtida Pill.*

A mixture of equal parts of aloes, assafœtida, and soap. See p. 400.

FERULA GALBANIFLUA, *Boiss.* and *Buhse*, and F. RUBRICAULIS, *Boissier*. Galbanum-yielding Plants.

These are large umbelliferous plants, with thin compressed fruits, ½ inch long and ¼ inch broad, growing plentifully on the slopes of the mountain ranges of Northern Persia.

Galbanum is supposed to be the *Chelbenah* of Scripture (see *Cycl. of Biblical Lit.*), the χαλβάνη of Hippocrates, and Dioscorides, who gives μετώπιον as an additional name. Theophrastus states it to be the produce of a *Panax*, Dioscorides of a *Ferula* of Syria. Arabic and Persian authors seem to have been well acquainted with the plant, as they give *kinneh* and *nafeel* as its names, and *barzud* as that of the gum-resin. D'Herbelot states that this is the same as the *pirzed* of the Persians, who call the plant yielding it *giarkhust*. Whatever the plant may be, it is as yet unknown to botanists. Lobel attempted to ascertain it by sowing some of the seeds which he found attached to galbanum, and obtained *Ferula Ferulago*, a native of North Africa and of Asia Minor, but which is not known to yield galbanum; while *Bubon galbaniferum*, which is sometimes adduced, is a native of the Cape of Good Hope.

The most recent and reliable information on this much-contested point is derived from the personal inquiries made by Buhse and Kotschy in their Persian travels. The former tells us that he found the plant (*Ferula galbaniflua*), from which galbanum is prepared, growing on the declivities of the Demawend mountains, at elevations varying from 4000 to 8000 feet. He considers it all but identical with *F. rubricaulis* (Berg. und Schmidt, *Offiz. Gewächse*, iv. tab. 31, b.), differing only in the absence of the commissural vittæ of the fruit. The natives called the plant *khassuch*. Borszczow (*Die Phar. Ferulaceen*, St Petersb. 1860) states that the gum-resin of *F. rubicaulis* is collected around Hamadan, and constitutes Persian galbanum. Some consider the galbanum of Persia to be so distinct from that commonly obtained from the Levant, that it must be the product of a different plant.

Galbanum is imported from India and the Levant, having probably been brought down the Persian Gulf.

1. **Galbanum**, *P.B.* *Galbanum.*

A gum-resin derived from an unascertained umbelliferous plant. Imported from India and the Levant.

Characters and Constituents.—In irregular tears, about the size of a hazel nut, usually agglutinated into masses, of a greenish-yellow or rich-brown colour; translucent, having a heavy, not unpleasant odour, remotely resembling savin and garlic, and an acrid bitter alliaceous taste.

Galbanum yields, when distilled with water, 7 per cent. of volatile oil, and is composed of 60 per cent. of resin, and about 35 of gum. The volatile oil is a colourless liquid, boiling at about 325°, having the concentrated odour of the gum-resin, and forming with dry hydrochloric acid a crystalline compound, $C_{10}H_{16}HCl$. The resin is soft; it is soluble in æther and alkaline solutions. When heated to 212° for some time with hydrochloric acid, it yields nearly 1 per cent. of *umbelliferone* (see p. 598), which may be removed from the acid liquid by means of æther or chloroform. It exists preformed in the gum-resin, for the characteristic blue fluorescence which it develops in the presence of alkalies is displayed when a drop of ammonia is added to water in which a lump of galbanum has been macerated for a short time. Umbelliferone is formed in less quantity in other aromatic umbelliferæ. The resin yields, on dry distillation, a fine blue aromatic and bitter oil, which Kachler has found to be composed of a colourless oil, $C_{10}H_{16}$, and a blue oil, $C_{10}H_{16}O$, which boils at 552°, and appears to be identical with blue oil of chamomile. When the resin is fused with caustic potash it furnishes 6 per cent. of resorcin (see p. 598), acetic, and volatile fatty acids.

Action and Uses.—Stimulant, carminative, and expectorant. Spread on leather, it is used as mild stimulant plaster to the chest and indolent swellings of the joints. It is a constituent of Pilula assafœtidæ composita, and of the following:—

2. **Emplastrum Galbani,** *P.B.* *Galbanum Plaster.*

Preparation.—Melt 1 ounce each of *galbanum* and *ammoniacum* together, and strain. Then add them to 1 ounce of *yellow wax* and 8 ounces of *lead plaster* melted together, and mix the whole thoroughly.

Uses.—A mild stimulant plaster, employed to give support to joints weakened by rheumatism, or thickened from degeneration of the synovial membrane.

DOREMA AMMONIACUM, *Don.* The Ammoniacum Plant.

The ammoniacum of Dioscorides (3 c. 88 or 98), and of Pliny, has been ascertained by Lindley and Falconer to be the produce of *Ferula Tingitana.* It grows in Cyrenaic Africa, near the temple of Jupiter Ammon, from which it derives its name. Morocco ammoniacum is still an article of commerce between Egypt and Arabia. It somewhat resembles the Persian drug, the produce of *Dorema ammoniacum*, a greyish gigantic herb with leafless branches, bearing numerous minute ball-like umbels of small flowers.

Characters.—*Root* large, perennial. *Stems* 7 to 9 feet high, about 4 inches in circumference at the base, clothed with glandular down, glaucous. *Leaves* large, petiolate, somewhat bipinnate, 2 feet long; pinnæ usually 3 pairs, remote: lower leaflets distinct; superior ones confluent, deeply pinnatifid; segments oblong, mucronate, quite entire, or rarely a little lobed, coriaceous, veined beneath, 1–5 inches long, and ½ to 2 inches broad, destitute of involucres; petiole ribbed, pubescent, much dilated, and sheathing at the base. *Umbels* proliferous, racemose, partial umbels globose, on short peduncles, usually disposed in a spicate manner. *Flowers* sessile, immersed in wool. *Calyx teeth* acute membranous. *Petals* white, ovate, with an inflexed point. *Disk* large, fleshy, cup-shaped, with a plicate, rather lobulate margin. *Stamens* and *styles* yellow, the latter complanate, recurved at the apex. *Stigmas* truncate. *Ovary* densely woolly. *Fruit* elliptic, dorsally compressed, with a broad flat margin. *Carpels* with 3 distinct filiform *ridges* near the middle, and alternating with them 4 obtuse secondary ridges (two of the primary ridges confluent with the margins); *vittæ* 1 to each secondary ridge, 1 to each primary marginal ridge, and 4 to the commissure, of which 2 (the exterior ones) are very small. *Habitat.*—The desert regions of Persia, from Shahrud in the north-west to the southern shores of the Sea of Aral.—*Don, Trans. Linn. Soc.*

The plant abounds in juice, which readily exudes on the slightest puncture: M. Fontanier says, spontaneously. Captain Hart states that when the plants have attained perfection, about the middle of June, innumerable beetles pierce it in all directions. The juice soon becomes dry, and is picked off. The finest pieces being kept separate, form the *ammoniacum in tears* of commerce, which vary in size, are yellow externally, and of a white, opaline, or waxy appearance when fractured. These, when pressed together, form *lump* or *amygdaloid Ammoniacum*, in which the tears appear agglutinated together by a softer material, often mixed with some of a darker colour. In the inferior kinds the tears are less abundant, and impurities, as sand, fruit of the plant, &c., are intermixed.

1. **Ammoniacum**, *P.B.* *Ammoniacum.*

A gum-resin derived by exudation from the plant above described, and collected in Persia and the Punjaub.

Characters and Constituents.—In tears or masses; the former varying in size from a pea to a hazel-nut, externally deep cream-coloured darkening to cinnamon-brown, internally milky-white, and breaking with a smooth, shining fracture; the masses composed of agglutinated tears, somewhat resembling benzoin; hard and brittle when cold, but readily softened with heat. Has a faint odour, and a bitter, subacrid, nauseous taste. Rubbed with water it forms a nearly-white emulsion like milk.

Ammoniacum yields, when distilled with water, nearly 2 per cent. of *volatile oil*, about 70 per cent. of *resin*, and 28 of *gum*. The volatile oil is the essence of the gum-resin, possessing the concentrated odour and taste of the drug. It is lighter than water, and according to some chemists contains a little sulphur. The resin is partly acid and partly neutral. The gum-resin is destitute of umbelliferone, but yields a little resorcin when fused with potash.

Action and Uses.—A stimulant expectorant, chiefly prescribed in chronic catarrh. It may be used like galbanum as a stimulant plaster.

Dose.—10 to 20 grains, in the form of emulsion or pill.

Pharmaceutical Uses.—A constituent of Emplastrum ammoniaci cum hydrargyro, E. galbani, Pilula scillæ composita, and P. ipecacuanhæ cum scilla.

2. **Mistura Ammoniaci**, *P.B.* *Ammoniacum Mixture.*

Prepared by rubbing ¼ ounce of *ammoniacum* in coarse powder, with 8 fluid ounces of *water* gradually added to form an emulsion, and finally straining through muslin.

Dose.—½ to 1 fluid ounce.

Other Gum-Resins furnished by Umbelliferous Plants.

1. SAGAPENUM, like the following, has been known to us since the time of the Greeks. Dioscorides describes it as the produce of a *Ferula* growing in India, and we have no more recent information. It is the *sukbeenuj* of the Arabs, who gave *sagafioon* as its Greek name. It reaches India from the Persian Gulf or the coasts of Arabia, but the supply is extremely limited.

Sagapenum is of a brownish-yellow or olive colour, chiefly in masses composed of agglutinated tears, sometimes in separate tears; these are more or less transparent, soft, and of a waxy consistence. It has an alliaceous odour and acrid taste, similar to but less powerful than that of assafœtida. Pelletier found it to be composed chiefly of resin and gum, with about 11·8 per cent. of volatile oil; but Brandes found only 3·7 of the last. Unlike assafœtida, the broken surface does not become pink on exposure.

2. OPOPANAX is described by Dioscorides as the produce of *πάνακες Ἡρακλειον*, a plant of Bœotia and Arcadia, which has been identified with the present *Opopanax Chironum*, referred by Sprengel to the genus Ferula. It is found also in the open fields of the south of France, of Italy, Sicily, and Greece, and, according to Merat and De Lens, also in Syria and the East. Dodoens first grew this plant from seeds found attached to pieces of opopanax; and he states that when wounded in warm weather, especially near the root, a juice exudes, which concretes into a gum resembling opopanax. But there is no proof that this plant yields the opopanax of commerce, which reaches India either from the Persian Gulf or the coast of Arabia, and is called *juwa sheer*, or the milk of *juwa*, as it was by Serapion. Opopanax was formerly imported into this country from Turkey; in the time of Matthioli it was obtained from Alexandria. It is now rarely met with.

Opopanax occurs in irregular-shaped but usually angular pieces of a reddish-yellow colour, sometimes speckled with white from the interior having become recently exposed; of a strong, rather fœtid odour, and of a bitter acrid taste; sp. gr. 1·62. It is composed chiefly of resin and gum, with 5·9 per cent. of volatile oil, which may be separated by distillation. It will form an emulsion with water.

Action. Uses.—Antispasmodic. It formerly enjoyed a high repute, as its name indicates, and was an ingredient of the Theriaca.

EURYANGIUM SUMBUL, *Kauffmann.* Musk-Root.

This is a tall perennial plant like a Ferula. The root was introduced into Russia about fifty years ago as a substitute for musk. It was admitted into our Pharmacopœia in 1867. In 1869 Fedschenks, a Russian traveller, discovered the plant which furnishes it in the mountains of Maghian, eastward of Samarkand. It flowered in Kew Gardens in the summer of 1875. Sumbul, in Persian and Arabic, signifies an *ear* or *spike*, and in India is especially applied to the roots of *Nardostachys Jatamansi*, Decand., the nardos or spikenard of the ancients.

Characters.—Root fusiform, perennial. *Stem* 8 to 10 feet high, giving off above the middle alternate spreading branches, and when wounded yielding a milky juice having the *flavour* of angelica and bitter. *Leaves* supradecompound. *Umbels* compound on short stalks. *Fruit* monocarpous.—*Kauffmann, Nouv. Mém. de la Soc. Imp. des Nat. de Moscou,* xii. 253, tab. 24 and 25; *J.D. Hooker, Bot. Mag.* 1875 (Anno).

1. **Sumbul radix,** *P.B.* *Sumbul Root.*

The dried transverse sections of the root of the above mentioned plant, imported from Russia and also from India.

Characters and Constituents.—The pieces are nearly round, from 2½ to 5 inches in diameter, and from ¾ to 1½ inch thick. They are covered on the outer edge with a dusky brown rough bark, frequently beset with short bristly fibres. The interior is porous, and consists of irregular, easily separated fibres. It has a strong odour, resembling that of musk. The taste is at first sweetish, but becoming bitterish and balsamic. That brought from India is closer in texture, denser, firmer, and of a reddish tint.

The dry root yields about 9 per cent. of *balsamic resin* of a musky odour, intensified by contact with water; a small proportion of *volatile oil*, which, according to Reinsch, is blue; a little *umbelliferone;* about ¾ per cent. of *angelic acid;* and a trace of *valerianic acid.* Solution of potash converts the resin into sumbulanic acid, which has a strong smell of musk, and forms crystalline salts.

Action and Uses.—Sumbul is a stimulant tonic and carminative, and is employed as a substitute for musk in nervous affections, such as spasmodic asthma, hysteria, and epilepsy. The following is the proper form for use:—

2. **Tinctura Sumbúl,** *P.B.* *Tincture of Sumbul.*

Prepared by exhausting 2½ ounces of *sumbul root* in coarse powder with 1 pint of *proof spirit* in the manner prescribed for Tinctura aconiti, and obtaining 1 pint of the tincture.

Dose.—10 to 30 minims.

The *Hydrocotyle Asiatica*, a small umbelliferous plant of India, resembling our *H. vulgaris*, is employed by the natives as diuretic and diaphoretic, and has been lately introduced into the Pharmacopœia of India as an alterative tonic. 5–10 grains of the powdered herb may be given as a dose, or ½–1 grain of the alcoholic extract.

The ARALIACEÆ contain several plants employed in medicine. *Panax quinquefolium*, of which the root, called *Ginseng*, is so highly esteemed by the Chinese as to be considered a *panacea*, and used to be sold for its weight in gold. It has a feeble odour, and a sweet, slightly aromatic taste, abounds in fecula, and can only be useful as a nutrient and demulcent. It is found in the northern parts of China, in Tauria, and in North America. A nearly allied species, *Panax Pseudo-Ginseng*, was found in the Himalayas by Dr Wallich. *Aralia nudicaulis*, a native of North America, having roots which are slightly fragrant, and of a sweetish aromatic taste, is sometimes called *false*, and used as a substitute for true *sarsaparilla. A. spinosa*, called *Angelica* or *Toothache-tree* in North America, is a stimulant diaphoretic.

The CORNACEÆ include plants that abound in bitter and astringent principles. According to Landerer, the fruit of *Cornus mascula* is in frequent use as a styptic among the Turks, being also employed by them in diarrhœa and cholera, and used in the manufacture of sherbet. The fruits of *C. officinalis* enter into the composition of popular fever-drinks in Japan. And the inspissated juice of the green bark of *C. circinata*, or the round-leaved cornel, has enjoyed a high reputation as an astringent tonic in the United States.

CUCURBITACEÆ, *Juss.* The Gourd Family.

These climbing herbs are known by unisexual flowers, contorted anthers, inferior 1-celled fruit composed of 3 carpels, ripening into some form of gourd, exalbuminous seeds, and flat orthotropal embryo. They are often possessed of bitter purgative properties.

CITRULLUS COLOCYNTHIS, *Schrader.* The Colocynth.

This annual plant, the Κολυκυνθίς of the Greeks, and *Hunzal* of the Arabs, has been used in medicine from the earliest times. In the 14th century it was one of the most important products of the isle of Cyprus. It is found in North Africa as far as Nubia, in Syria, and in the southern parts of India.

Characters.—Root annual, thick, whitish. *Stem* procumbent, angular, hispid. *Leaves* cordate-ovate, divided into many lobes; *lobes* obtuse, bright green on the upper surface, whitish below, and scabrous, with small white hairs and often hair-bearing tubercles; *petioles* as long as the lamina; *tendrils* short. *Flowers* axillary, solitary stalked. *Calyx* with 5 subulate segments. *Female flowers* with the tube of the calyx globose, and somewhat hispid, the limb campanulate, with narrow segments. *Petals* small, yellow, with greenish veins, scarcely adherent to each other and to the calyx. *Fruit* globose, smooth, about the size of an orange, with a thin but dense rind, 6-celled, pulp very bitter. *Seeds* ovate, not marginate, whitish, sometimes brownish, bitter.

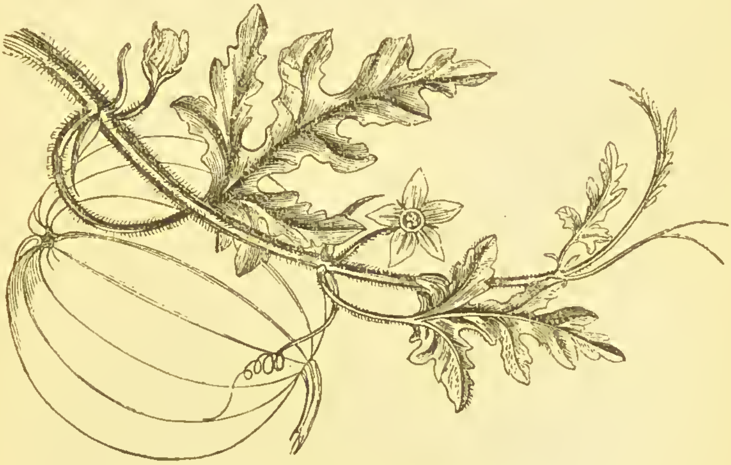

Fig. 98.—*Citrullus Colocynthis.*

The dry fruit is the part employed in medicine. It is imported in two forms:—1. *Unpeeled*, from Mogadore in its entire state, about 3 inches in diameter, and covered by its hard yellow rind. 2. *Peeled*, from the Levant (by Smyrna and Trieste), north of Africa (by France), and south of Spain; with the rind peeled or pared off, and the pulp dried when the fruit is ripe. It then appears in the shape of white balls, which are light, porous, and spongy, but tough, usually with the seeds forming about $\frac{3}{4}$ of the whole weight. The smaller variety of fruit is considered the best, and is sometimes imported with the seed removed. This is always required to be done before any preparations can be made.

1. Colocynthidis Pulpa, *P.B.* *Colocynth Pulp.*

The dried decorticated fruit freed from seeds. Imported chiefly from Smyrna, Trieste, France, and Spain.

Characters and Constituents.—Light, spongy, white or yellowish-white, odourless, intensely bitter.

According to Walz, the active principle is due to *colocynthin*, $C_{56}H_{84}O_{23}$, of which the pulp yields only ¼ per cent. The other constituents, according to Meisner, are as follows:—*Bitter resin* 13·2 per cent., *bitter principle* 14·4, *extractive* 10, *gummy matters* 30, *phosphate of lime and magnesia* 5·7, and *lignin* 19·2 per cent. According to Herberger and Braconnot, the bitter principle is reddish-yellow in mass, but yellow when in powder; transparent and friable, excessively bitter, burning like a resin, soluble in five parts of cold and in less boiling water; equally soluble in alcohol and æther. Acids and the deliquescent salts precipitate it as a coherent and viscid mass; alkalies do not precipitate it, neither does infusion of galls. Walz's colocynthin forms yellowish tufts of crystals. It is a violent purgative, and when boiled with dilute hydrochloric acid is resolved into colocynthein, $C_{44}H_{64}O_{13}$, and grape sugar. Walz has also separated another principle (colocynthitin) from the alcoholic extract of the pulp, by means of æther in which it is soluble. It exists in the form of a tasteless crystalline powder.

Substitutes.—In India two other species are employed instead of the foregoing; they are *Cucumis trigonus*, Roxb. (*C. Pseudo-colocynthis*, Royle), and *C. Hardwickii*, Royle. The fruit of the former is spherical, but has a tendency to become elongated and trigonous. The fruit of the latter is oval.

Action and Uses.—Colocynth is a powerful hydragogue purgative, producing in large doses gastro-intestinal inflammation and collapse. Sir R. Christison mentions a case in which a teaspoonful and a half of the powdered pulp caused death. It is never given alone, but as an adjunct to weaker purgatives to insure their action. Thus employed it is an extremely useful drug. The purgative effects of the drug are due, not simply to a local irritant action, but to the elimination of the purgative principles from the blood. The liver undoubtedly takes an active part in this process. The following are good forms for the exhibition of the drug:—

2. Extractum Colocynthidis compositum, *P.B.* *Compound Extract of Colocynth.*

Preparation.—Macerate 6 ounces of *colocynth pulp* in 1 gallon of *proof spirit* for four days; press out the tincture and distil off the spirit, then add 12 ounces of *extract of Socotrine aloes*, 4 ounces of *resin of scammony*, and 3 ounces of *hard soap* in powder, and evaporate by a water bath until the mixture is of a suitable consistence for forming pills, adding towards the end of the process 1 ounce of *cardamom seeds* in fine powder.

Dose.—3 to 10 grains.

3. **Pilula Colocynthidis composita,** *P.B.* *Compound Colocynth Pill.*

Preparation.—Mix thoroughly 1 ounce of *colocynth pulp* in powder, 2 ounces each of *Barbadoes aloes and scammony,* both in powder, and ¼ ounce of *sulphate of potash* in powder, then add 2 fluid drachms of *oil of cloves,* and beat into a mass with the acid of sufficient water.

Dose.—5 to 10 grains.

4. **Pilula Colocynthidis et Hyoscyami,** *P.B.* *Colocynth and Henbane Pill.*

A mixture of 2 parts by weight of *compound colocynth pill* and 1 part of *extract of hyoscyamis,* beaten together into a uniform mass. The addition of henbane prevents the tendency to griping which the colocynth pill sometimes produces in those who have a delicate mucous membrane.

Dose.—5 to 10 grains.

ECBALLIUM OFFICINARUM, *A. Richard.* Squirting Cucumber.

This plant was known to the Greeks, and called Σίκυς ἄγριος, and sometimes Ελατήριον, a name also applied to the fæculence of the juice of its fruit, the process of obtaining which is described by Dioscorides. Ecballium is derived εκβάλλω, to expel.

The plant is indigenous to the Mediterranean and Euxine regions. It is cultivated at Hitchin and Mitcham.

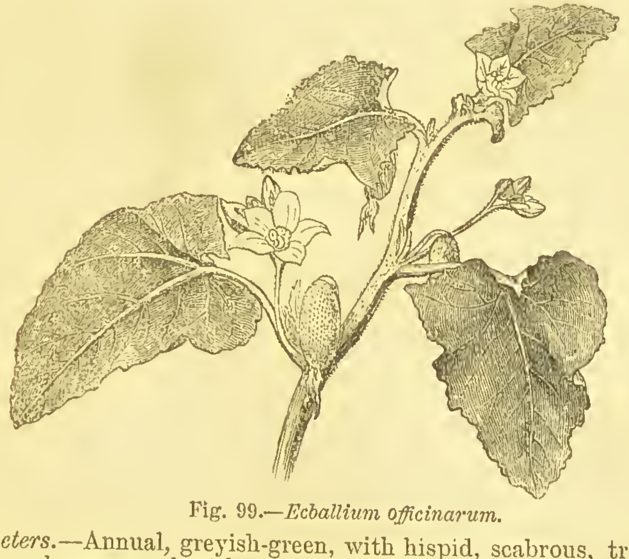

Fig. 99.—*Ecballium officinarum.*

Characters.—Annual, greyish-green, with hispid, scabrous, trailling *stems,* which are glaucous and without tendrils. *Leaves* cordate, somewhat lobed, crenately toothed, very rugose, on long bristly stalks. *Flowers* monœcious. ♂ *Calyx* 5-toothed. *Corolla* yellow, 5-parted. *Stamens* triadelphous, with connate anthers. ♀ *Filaments* 3, sterile. *Style* trifid. *Stigmas* bifid. *Ovary* 3-celled, with many ovules. The fruit ovate, 1½ inch long, muricated; when mature, and detached from its stalk, it contracts with elasticity, and forcibly projects the juice and seeds from an orifice, formed by separation of the stalk. *Seeds* brown, compressed, reticulate.—*Esenb. and Eberm.* 272; *Steph. and Church*, pl. 34.

1. **Ecballii fructus**, *P.B.* *Squirting Cucumber Fruit.*

The fruit very nearly ripe. When quite ripe, the active pulp is apt to be lost by the spontaneous squirting of the fruit, due to the imbibition of fluid, until the internal pressure becomes so great as to cause a discharge of the pulp through the weakest part of the seed-vessel, which is that opposite the attachment of the stalk. This usually occurs at the time when the ripe fruit is ready to fall from the stalk.

2. **Elaterium**, *P.B.* *Elaterium.*

A sediment from the juice of the fruit.

Preparation.—Cut the fruit of the *squirting cucumber* lengthwise, and lightly press out the juice. Strain it through a hair sieve; and set it aside to deposit. Carefully pour off the supernatant liquor; pour the sediment on a linen filter, and dry it on porous tiles with a gentle heat. The decanted fluid may deposit a little more sediment, which may be dried in the same way.

Dr Clutterbuck has proved that it is contained only in the juice around the seeds, which is of a gelatinous consistence. The rest of the fruit is comparatively inert. When the fruit is sliced and placed upon a sieve, a limpid and colourless juice flows out, which after a time becomes turbid, and then deposits a sediment. This, when dried, is light and pulverulent, of a light yellowish-white colour tinged with green, and is genuine elaterium, of which Dr Clutterbuck obtained only 6 grains from 40 of these cucumbers; and found $\frac{1}{8}$ of a grain to produce powerful cathartic effects.* The method now adopted for obtaining elaterium is in conformity with these experiments.

Characters, Constituents, and Tests.—In broken, curved, buscuit-like fragments, about $\frac{1}{10}$ of an inch thick, marked on the convex surface by the impressions of the calico filter; light and friable; when fresh pale-green, becoming after a short time greenish-grey, and ultimately drab-coloured, and exhibiting a minute crystalline efflorescence on the surface; acrid and bitter; fracture finely granular. Does not effervesce with acids (absence of chalk); yields half its weight to boiling rectified spirit. This solution, concentrated and added to warm solution of potash, yields on cooling, not less than 20 per cent. of *elaterin*, $C_{20}H_{28}O_5$ in colourless crystals (showing a proper proportion of the active principle).

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* At Hitchin and Mitcham one bushel, or forty pounds of the fruits, yields about half an ounce of elaterium.

At the Mitcham gardens elaterium is manufactured very much in the above way, only that considerable force is used in the expression of the juice, and the product is therefore less potent, though more abundant. The manufacture usually commences about the second week in September.

According to Hanbury and Flückiger, chloroform is the best solvent. By exhausting the drug with chloroform and adding the solution to æther, a white crystalline deposit of elaterin is immediately formed, which may be washed with æther and recrystallised from chloroform. By this process they obtain 36·6 per cent. of elaterin, from the drug carefully prepared in London; and 27·6 per cent. from that of Malta (*Pharmacographia*, p. 262). The commercial article is much more variable, the proportion of elaterin ranging from 44 to 5 per cent. According to Köhler, the juice of the fruit contains 95 per cent. of water, 3 to 3½ per cent. of organic and 1 to 1·6 of inorganic matter; and he states that the percentage of elaterin gradually diminishes as the summer advances, until September, when he failed to obtain any. Walz found a second crystallisable bitter principle in elaterium, and also an amphorous acid; the former is a glucoside, and he has named it *Prophetin.*

2. **Elaterin** forms colourless hexagonal scales or prisms of intensely bitter and slightly acrid taste. It is freely soluble in boiling alcohol and in chloroform; its solutions are neutral, and it is not precipitated by tannic acid or metallic salts. According to Buckheim, it is decomposed by strong alkaline solutions.

Action and Uses.—Elaterium is a local irritant, and the manipulation of the fruits in the preparation of the drug sometimes causes ulceration of the fingers. Internally given, its effects are similar to if not identical with those of the active constituent of colocynth. It is absorbed into the blood, and is eliminated by the liver and intestinal mucous membrane, inducing a great outpouring of water from the blood-vessels. It is indeed the most powerful hydragogue purgative that we possess, and 2½ grains have caused death in an adult, the fatal issue being due to violent gastrointestinal inflammation, attended by uncontrollable vomiting and purging. Where energetic treatment is required to ward off immediate danger, elaterium is a most valuable remedy. Thus it is employed as an indirect means of depletion, where there is undue tension of the blood-vessels with diminished secretion, as in congestion of the brain or kidneys. In apoplexy it may be given to relieve plethora and to the stay further effusion. In ascites and general dropsy, especially that associated with renal disease, where the use of diuretics is contraindicated, elaterium is the appropriate remedy when less active purgatives fail, or when there is a sudden extension of the œdema to the lungs or other important viscera.

Dose.—Of elaterium $\frac{1}{16}$ to $\frac{1}{2}$ grain; the initial dose should not exceed the $\frac{1}{6}$ of a grain, on account of its great variability. Indeed, on this account it would be well if elaterin, the definite crystalline active constituent of the drug, were substituted in its place. Of this the dose would be the $\frac{1}{40}$ to $\frac{1}{8}$ of a grain.

3. **Pulvis Elaterii compositus,** *P.B.* *Compound Elaterium Powder.*

An intimate mixture of 1 part by weight of *elaterium* and 9 parts of *sugar of milk.*

Dose.—$\frac{1}{2}$ to 5 grains.

MYRTACEÆ, *R. Brown.* The Myrtle Family.

These plants are botanically allied to the Rosaceæ. They are chiefly distinguished by the valvular æstivation, the solitary style, dotted leaves; and medicinally, by their prominent aromatic qualities.

MELALEUCA MINOR, *Decand.* The Cajuput Tree.

This is a variable tree, and often attains considerable size. It is indigenous to the Molucca islands and to the southern and north-eastern regions of Australia. It has been distributed over the whole of India. The plant above mentioned is regarded as a variety of *M. leucadendron* (*arbor alba*). Rumphius describes two trees:—α, *Arbor alba major*, Herb Amboin, ii. t. 16; and β, *Arbor alba minor*, ii. t. 17, f. 1. The latter is the variety which grows in Bouro, from whence *Kayapootee oil* (*i.e.* oil of the white-wood or white-tree) is chiefly derived. It is called *Daun kitsjil.*

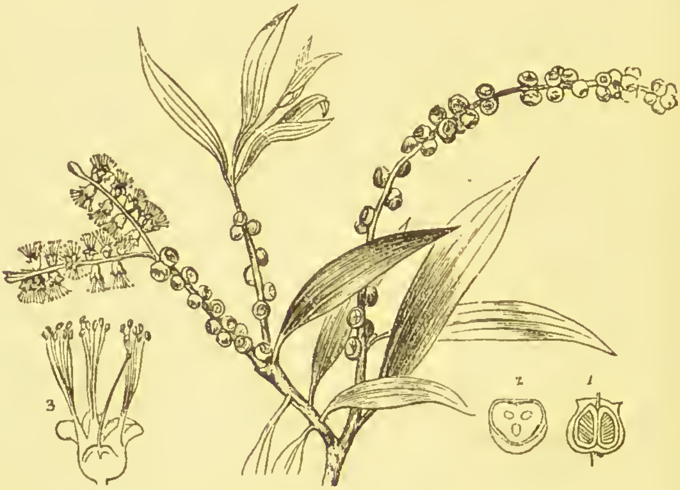

Fig. 100.—*Melaleuca minor.* 1, fruit in vertical; 2, in transverse section; 3, a flower.

Characters.—A small tree, with an erect but crooked stem covered with thick, rather soft, light-coloured bark; branches scattered, with slender twigs, which droop like those of the Weeping Willow. *Leaves* alternate lanceolate, acute, slightly falcate, 3 to 5-nerved, while young silky, and diffusing a powerful odour when bruised. *Spikes* terminal and axillary, downy as well as the calyx and branchlets, while in flower there is only a scaly conic bud at the apex, which soon advances into a leafy branchlet. *Bracts* solitary, 3-flowered. *Calyx* urceolate, limb 5-parted. *Petals* 5, white, scentless. *Stamens* from 30 to 40, in five bundles; *filaments* 3 or 4 times longer than petals; *anthers* incumbent, with a yellow gland at the apex. *Style* long; *stigma* obscurely 3-lobed *Ovary* ovate, and like the capsule 3-celled, many-seeded, lower half united with, but the capsule is enclosed within the thickened tube of the calyx. *Seeds* wedge-shaped.—*Steph. and Church, Med. Bot.* plate 84.

The leaves are collected on a warm dry day in autumn, and placed in dry sacks, in which they nevertheless become heated and moist. They are next cut in pieces, macerated in water for a night, and then distilled. Two sackfuls of the leaves yield only about 3 drachms of the oil.

1. **Oleum Cajuputi**, *P.B.* *Oil of Cajuput.*

The oil distilled from the leaves of the plant above described, imported from Batavia and Singapore.

Characters and Constituents.—Very mobile, transparent, sp. gr. ·926, boils at 343°; of a fine pale bluish-green colour, strong agreeable camphoraceous odour, and warm aromatic taste, leaving a sensation of coldness in the mouth.

According to Schmidl and Gladstone, it consists chiefly of *hydrate of cajuputene*, $C_{10}H_{16},H_2O$. This, when distilled from phosphoric anhydride, yields cajuputene, $C_{10}H_{16}$, which has the odour of hyacinths. The freshly distilled oil has a fine green tint, which is lost by keeping; to prevent this, the oil is preserved in copper vessels, whereby it attains a trace of copper, which confers a permanent bluish-green tint. That the colour of old oil is due to this cause is readily proved by agitating it with a little hydrochloric acid and plunging into the mixture a strip of platinum and one of zinc, when copper is immediately deposited on the platinum.

Substitutes.—Several species of *Melaleuca*, *Metrosideros*, and *Eucalyptus* yield oils which closely resemble that described above.

Action and Uses.—Cajuput oil is a mild and pleasant rubefacient, applied externally. Internally it is stimulant, carminative, and diaphoretic, and is chiefly prescribed for flatulent colic.

Pharmaceutical Uses.—It is a constituent of Linimentum crotonis and the following:—

2. **Spiritus Cajuputi**, *P.B.* *Spirit of Cajuput.*

A mixture of one volume of *oil of cajuput* and 49 of *rectified spirit.*

Dose.—½ to 1 fluid drachm.

CARYOPHYLLUS AROMATICUS, *Linn.* The Clove.

This is an elegant evergreen shrub, resembling the Pimento. It is a native of the Moluccas. It is now cultivated in Malacca, Sumatra, India, the West Indies, Guyana, and on the eastern coast of Africa. Pliny describes a spice called *Caryophyllon* (Καρυόφυλλον), and the Arabs give *Kurphullon* as the Greek name of cloves.

Characters.—The wood, like that of Pimento, is hard, and covered with a smooth grey bark. *Leaves* opposite and decussate, ovate-lanceolate, tapering towards both ends, about 4 inches long, somewhat leathery, shining, and minutely dotted, diffusing a clove-like fragrance when bruised. *Panicles* short, trichotomously divided, jointed at every division. *Calyx-tube* is cylindrical, of a dark purple colour, adhering to the ovary, divided into 4 ovate concave segments. *Petals* 4, overlapping each other, and of a globular form when in bud, afterwards spreading, roundish, whitish, and said to exhale a grateful odour. Within the calyx and at the top of the ovary is a quadrangular disk, surrounding but not embracing the base of the short obtuse style. *Stamens* in 4 bundles, filaments long, yellow. *Ovary* nearly cylindrical, 2-celled, with many small ovules in each cell attached to the sides of the dissepiment. *Fruit* a large elliptical berry, containing a single seed, by the growth of which the second cell and numerous ovules have been obliterated. *Embryo,* large, elliptical, dotted. *Cotyledons* unequal, sinuose, the larger one partly enveloping the smaller, including the superior radicle.—*Bot. Mag.* iv. plates 2749 and 2750.

Cloves, the unexpanded flower-buds, are picked by hand or with long reeds, and then quickly dried in the shade. The best are obtained from the Moluccas. They are exported from Penang, Bencoolen, and Amboyna. They have some resemblance to a nail, whence the French name of *clou de girofle.*

1. **Caryophyllum,** *P.B.* *Cloves.*

The dried unexpanded flower-buds of the plant above described, cultivated in Penang, Bencoolen, and Amboyna.

Characters, Constituents, and Tests.—About ½ inch long, dark reddish-brown, plump and heavy, consisting of a nearly cylindrical body (tube of calyx become adherent to and confused with the ovary), surmounted by 4 teeth (limb of the calyx), and a globular head (the imbricated unexpanded petals), with a strong fragrant odour, and a bitter, spicy (pimento-like) pungent taste. It emits oil when indented with the nail (a proof that the buds have not been previously exhausted of their oil).

Cloves are remarkable for the great quantity of *volatile oil* which they contain, amounting as it does to 16 or 18 per cent. They contain also three small quantities of other volatile constituents, *eugenin,* $C_{10}H_{12}O_2$, *salicylic acid,* and *carophyllin,* $C_{10}H_{18}O$, about 16 per cent. of a peculiar tannic acid, 13 per cent. of gum, 4 of extractive, 28 of lignin, and about 18 per cent. of water.

Eugenin has the same composition as eugenic acid; it occasionally separates from oil of cloves in the form of tasteless crystalline laminæ. Carophyllin is isomeric with camphor; it occurs in the form of needle-shaped prisms, which are tasteless and colourless.

Substitutes.—*Clove stalks,* which contain about 5 per cent. of volatile oil, and *clove fruits* (mother cloves), ovate berries about 1 inch long, and containing about 5 to 8 per cent. of volatile oil, and pimento fruits (allspice), are used to adulterate powdered cloves. All these substitutes have thick-walled wood-cells, which are not found in the immature flower-bud.

Action and Uses.—Stimulant and carminative, they are much employed to flavour articles of diet and medicines, viz., Infusum aurantii compositum, Mistura ferri aromatica, Vinum opii.

2. **Oleum Caryophylli,** *P.B.* *Oil of Cloves.*

The oil distilled in Britain from cloves. Being heavier than water it is best distilled from weak brine.

Characters and Constituents.—A colourless liquid when recent, but gradually becoming yellowish, and at last red-brown; sp. gr. 1·046 to 1·058, therefore sinking in water. It has a concentrated odour and taste of cloves. Like the other volatile oils, it is a mixture of a hydrocarbon and an oxygenated oil. The former, called *light oil of cloves,* is lighter than water—sp. gr. ·91, boils at 484°, and has the composition $(C_{10}H_{16})_2$. The latter, called *eugenol* or *eugenic acid*, $C_{10}H_{12}O_2$, has the sp. gr. 1·068, boils at 486°, and has also a powerful taste and smell of cloves. It forms crystallisable salts with the alkalies. These two constituents of oil of cloves exist in variable proportions.

Action and Uses.—The volatile oil is the essence of cloves; it is very pungent and somewhat styptic, owing to which properties it is a good remedy in toothache. It is employed by the microscopist instead of oil of turpentine to render animal tissues transparent before mounting them in balsam or varnish.

It is used in the following preparations to prevent griping:—Confectio scammonii, Pilula colocynthidis composita, and P. colocynthidis et hyoscyami.

3. **Infusum Caryophylli,** *P.B. Infusion of Cloves.*

Prepared by infusing ¼ ounce of *bruised cloves* in 10 ounces of *water* for half an hour in a covered vessel, and straining. Containing as it does a considerable quantity of tannic acid, it is incompatible with the salts of iron and the alkaloids.

Dose.—1 to 4 fluid ounces as an aromatic stimulant and carminative, or as a vehicle for other medicines, especially aperients.

EUGENIA PIMENTA, *Linn.* The Pimento or Allspice.

A native of South America and the West Indies. In the latter it is much cultivated in regular walks. Besides Pimento, it is also called "*Jamaica pepper.*"

Characters.—An elegant *tree* about 30 feet high, foliage dense and evergreen, branches round, twigs compressed, the younger as well as the pedicles pubescent. *Leaves* petiolate, oblong or oval, marked with pellucid dots, smooth; *peduncles* axillary and disposed in terminal trichotomous panicles. *Calyx* and *petals* 4-fid, the latter reflected greenish-white. *Stamens* numerous. *Ovary* 2–3-celled; ovules numerous. *Berry* spherical, covered by the roundish persistent base of the calyx, which when ripe is smooth, shining, and of a dark purple colour; 1, rarely 2-celled; 2-seeded. *Embryo* roundish, cotyledons united into one mass, radicle scarcely distinct.—*Nees von E.* 298; *Woodv. Med. Bot.* pl. 26 (*Myrtus Pimenta*).

Browne (*Nat. Hist. of Jamaica*) describes the berries as being gathered before they are ripe, because they subsequently lose their aromatic warmth, acquire a taste like juniper-berries, and are much eaten by birds. When gathered, they are carefully dried in the sun.

1. **Pimenta,** *P.B. Pimento.*

The dried unripe berries of the plant above described. From the West Indies.

Characters and Constituents.—Of the size of a small pea, brown, rough, crowned with the teeth of the calyx, yellowish within, and containing two dark-brown seeds; odour aromatic; taste hot and spicy.

The berries yield from 3 to 4½ per cent. of *volatile oil* (see below), a large quantity of *tannic acid*, a little *fixed oil* and *starch.*

Action and Uses.—A stimulant aromatic carminative. It is used as a spice, and flavouring adjunct to medicines. It is a constituent of Syrupus rhamni.

2. **Oleum Pimentæ**, *P.B.* *Oil of Pimento.*

The oil distilled in Britain from pimento.

Characters and Constituents.—A colourless liquid, becoming reddish and finally brown by age; sp. gr. 1·037, therefore sinking in water; having the concentrated odour and taste of pimento, which resemble those of cloves. Like the latter, it is composed of a hydrocarbon lighter than water and of the oxydised constituent *eugenic acid.* This is the Essence of Pimento. It may be employed for the same purposes as oil of cloves.

3. **Aqua Pimentæ**, *P.B.* *Pimento Water.*

Prepared by distilling 14 ounces of *bruised pimento* with 2 gallons of *water*, and obtaining 1 gallon.

Use.—An agreeable vehicle for saline and other medicines.

PUNICA GRANATUM, *Linn.* The Pomegranate.

The Pomegranate, a native of the mountainous countries from Syria to the north of India, must always have been an object of attention. It is the *rimmon* of the Bible, and the *rooman* of the Arabs. It was well known to the Greeks and Romans.

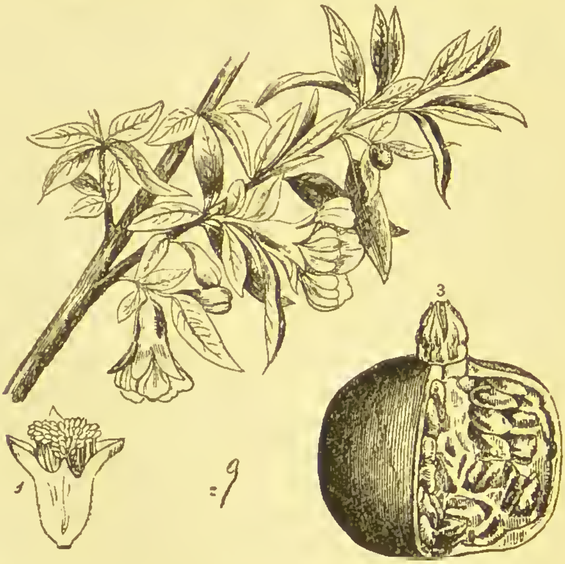

Fig. 101.—*Punica Granatum.* 1, flower; 2, stamen; 3, fruit.

Characters.—*Stem* arborescent and irregular, in arid situations rather thorny. *Leaves* usually opposite, often fascicled, oblong lanceolate, entire, not dotted, smooth, shining, and dark green. *Flowers* commonly solitary, of a brilliant scarlet. *Calyx* thick and fleshy, adhering to the ovary, turbinate, 5 to 7-cleft. *Petals* 5 to 7, crumpled; stamens numerous, often double. *Style* filiform. *Stigma* capitate. *Fruit* of the size of a large apple, with a thick leathery rind, and crowned by the erect limb of the calyx; cells several, arranged in two strata, separated from each other by an irregular transverse diaphragm, lower division of 3 cells, the upper of from 5 to 9 cells. *Seeds* numerous, imbebbed in pellucid pulp, with foliaceous, spirally convolute cotyledons.—*Nees von E.* 301; *Steph. and Church, Med. Bot.* pl. 57.

The parts of this plant employed by the ancients are all still used in the East. Thus the flowers are the *Balaustion* of the ancients. In India, *buloositoon* is given as the Greek name of the double flower. They are devoid of odour, but have a bitterish and astringent taste, tinge the saliva of a reddish colour, contain tannin, and strike a black with ferruginous salts. They are not now officinal.

The rind of the fruit (*cortex granati*) especially of the *wild* plant, is extensively employed as an astringent and as a dye in the East. It is of a reddish-brown colour and smooth externally, but yellow on the inside; occurs usually in regular fragments, dry, hard, and leathery, of a very astringent taste. It contains of *tannin* 18·8 per cent. with 10·8 of *extractive*, and 17·1 of *mucilage*, and is used for tanning in some countries.

The bark of the root (see below) was employed as an anthelmintic by Dioscorides and Celsus, and still is so in India. It was reintroduced into practice by Drs Buchanan and Anderson. It is now obtained from the south of Europe. The root itself is heavy, knotted, and of a yellow colour; its bark is sold in strips, quills, or fragments, sometimes with parts of the root still adhering to it.

2. **Granati radicis cortex**, *P.B.* *Pomegranate-root Bark.*

The dried bark of the root obtained from the south of Europe.

Characters and Constituents.—In quills or fragments of a greyish-yellow colour externally, yellow internally, having a short fracture, little odour, and a very astringent and slightly bitter taste. It is blackened by the solution of a persalt of iron. It contains 22 per cent. of *tannic acid*, with a little *gallic acid*, and a considerable quantity of *mannite*. The tannic acid is a distinct variety called *punico-tannic acid* $C_{20}H_{16}O_{13}$, which when boiled with dilute sulphuric acid is converted into ellagalic acid $C_{14}H_6O_8$ a derivative of gallic acid and a constituent of Oriental bezoars, and sugar.

Adulterations.—The bark of the stem and branches, which is less corky; and the bark of the common box (*Buxus sempervirens*) and Barberry (*Berberis vulgaris*). These latter resemble the bark of the pomegranate root, but they are not blackened by the salts of iron.

Action and Uses.—Both the rind of the fruit and the bark of the root are powerfully astringent. The former is a valued remedy for diarrhœa and chronic dysentery in India. The Chinese, Hindoos, Greeks, and Romans have from time immemorial used the bark of the root for another purpose, viz., the expulsion of tapeworm, but the evidence of those who assert its efficacy is in favour of the use of the fresh root. The dry bark certainly does not appear to contain any particular tænicide principle.

The following is the form in which the drug should be given:—

2. **Decoctum Granati radicis,** *P.B.* *Decoction of Pomegranate Root.*

Preparation.—Boil 2 ounces of *pomegranate root bark* in 2 pints of *water* to a pint, and strain, making the strained product measure a pint if necessary by washing the contents of the strainer with a little water.

Dose.—½ to 1 ounce as an astringent; as a tænicide, 1 to 2 ounces repeated after four hours, and followed by a purgative.

ROSACEÆ, *Endlich.* The Rose Family.

Through Acacia the Leguminosæ very closely approach this order, the fruit of which however is never leguminose, and the corolla is always regular. The Rosaceæ form three natural subdivisions—the *Roseæ* proper, the *Pomeæ*, and the *Amygdaleæ.* The Pomeæ have a limited number of ovaries, and they become adherent to each other and to the fleshy tube of the calyx to form the fruit known as the Pomum or Apple. The Amygdaleæ are distinguished by the solitary non-adherent, and consequently superior ovary, and solitary ovule, the whole ripening into a drupe, and the presence of hydrocyanic acid in the leaves, and gum in the bark. Through Pomeæ the order approaches Myrtaceæ; its medicinal properties are fully illustrated in the following plants.

POTENTILLA TORMENTILLA, *Nesl.* Common Tormentil.

Tormentil has been long employed in medicine, and was probably known to the Greeks. Its bright yellow flowers enliven our heaths and meadows, and it is common throughout Europe.

Characters.—*Root* very large and woody, knotted. *Stems* wiry, numerous, semiprocumbent, and spreading. *Leaves* ternate, sessile or shortly stalked, ternate, the lower leaves quinate on long petioles; leaflets oblong, acute, deeply serrated, a little hairy; stipules smaller, deeply cut. *Flowers* yellow. *Calyx* concave, usually 8-parted, in two rows, the exterior smaller. *Petals* 4, sometimes 5. *Stamens* numerous. *Style* lateral. *Fruit* consisting of numerous small nuts collected upon the flattish dry receptacle; in this species these nuts are longitudinally wrinkled. *Seeds* suspended.—Common on heaths and meadows throughout Europe.—*Eng. Bot.* t. 863; *Steph. and Church,* pl. 26.

The rhizome or rootstock is tuberous and knotty, with numerous radicles, of a dark-brown colour on the outside, and reddish internally, with little smell, but having a strong astringent taste. It contains about 17 per cent. of *tannin*, with *colouring matter*, *gum*, and a little *volatile oil.* It is employed in the north for tanning.

Action. Uses.—Astringent. Useful in diarrhœa or chronic dysentery, in doses of 30 to 40 grains.

1. **Decoctum Tormentillæ.** *Decoction of Tormentil.*

Prepared by boiling 2 ounces of the dry *bruised root* in 1½ pint of *water* to 1 pint, and straining.

Dose.—1 to 2 ounces. It may be used as an astringent lotion or injection.

ROSA CANINA, *Linn.* The Dog Rose.

This variable species is common in our hedges and thickets.

Characters.—A *bush* 10 feet high, shoots ascending, mostly withous setæ, with uniform hooked prickles. *Leaves* glandless, naked, or only slightly hairy, the serratures simple or compound. *Flowers* rose-red. Limb of *Calyx* pinnate, deciduous. *Styles* distinct. *Fruit* (see below).—*Eng. Bot.* pl., 992; *Steph. and Church*, pl. 100.

1. **Rosæ Caninæ fructus,** *P.B.* *Fruit of the Dog-Rose. Hips.*

The ripe fruit of the above described, and other indigenous allied species.

Characters and Constituents.—Fruit an inch or more in length, ovate, scarlet, smooth, shining; taste sweet, sub-acid, pleasant.

Bilz finds the pulp to contain 3 per cent. of free *citric acid*, 7·7 of free *malic acid*,, 25 per cent. of *gum*, 30 of uncrystallisable *sugar;* and the *citrates* and *malates* of *potash* and *lime.*

2. **Confectio Rosæ Caninæ,** *P.B.* *Confection of hips.*

Preparation.—Beat 1 pound of *hips* deprived of their seeds to a pulp in a stone mortar, and rub the *pulp* through a sieve, then add 2 pounds of *refined sugar*, and rub them well together.

Test.—A filtered infusion of the confection gives a copious precipitate (citrate of lime) with lime water, entirely soluble in solution of citric acid, proving the absence of sulphuric acid, which is sometimes added to the confection to brighten the colour. Confection with this addition forms with grey powder, subsulphate of mercury (see p. 284) which is a powerful irritant.

Pharmaceutical Uses.—An ingredient of Pilula quiniæ. It is chiefly employed as a means of forming insoluble or disagreeable powders into pills. Metallic oxydes are incompatible with the free citric and malic acids of the confection.

ROSA CENTIFOLIA, *Linn.* The Hundred-leaved or Cabbage Rose.

This rose is a native of the Eastern Caucasus. It has been long introduced into Europe. It is commonly grown in gardens, and is cultivated for medicinal use at Mitcham, and in the market gardens in the neighbourhood of London. It is a large double rose, of a bright pink colour, and delicious odour.

Characters.—A *bush* with erect shoots, which are rather thickly covered with nearly straight prickles, scarcely dilated at the base, intermixed with glandular bristles, all of different forms and sizes, the large ones falcate. *Leaflets* 5 to 7, oblong or ovate, glandular at the margin. *Flowers* several together, drooping. *Buds* short, ovate, with leafy bracts. *Sepals* in flowering, spreading not deflexed, leafy, more or less pinnate, and with the peduncles covered with short setæ, tipped with a fragrant brown viscid secretion. *Fruit* ovate.—*Nees von E.* 302; *Woodv. Med. Bot.* pl. 140.

The petals of this species are well known for their fragrance; on which account, as well as for the beauty of the flowers, they are extensively cultivated, and consequently numerous varieties have been produced; so that it is difficult to say which is a species and which only a variety. In Turkey, and at Shiraz in Prussia, and many parts of India, the variety of the cabbage rose, known as *R. Damascena*, or Damask Rose, is cultivated for the purpose of yielding the *Attar* of Roses, as well as Rose water. As the species of rose are few in India, perhaps the same may be cuitivated in the extensive rose gardens of Ghazipore, which is the great mart for attar in India. The petals should be collected just when fully blown. If quickly dried they will long retain much of their fragrance, especially when preserved with salt.

1. **Rosæ centifoliæ petala**, *P.B.* *Cabbage Rose Petals.*

The fresh petals fully expanded, from plants cultivated in Britain.

Characters and Constituents.—Taste sweetish, and faintly bitter and astringent; odour roseate; both taste and odour readily imparted to water. According to Enz, the petals contain *malic*, *tartaric*, and *tannic acids; fat*, *resin*, and *sugar*. The odour is due to *volatile oil*, which exists in very small quantity, about 0·04 per cent. This is the costly and delicious Attar or Otto of Roses.

2. **Oleum Rosæ.** *Volatile Oil, Attar or Otto of Roses.*

Production.—The chief supply of the oil is obtained from Turkey. It is the produce of the province of Rumalia, on the southern side of the Balkan mountains. It is distilled, in copper stills, from the fresh flowers, including the calyces. The first portions of the distillate are returned to the still; that subsequently obtained is set by for twenty-four or forty-eight hours at a temperature not lower than 59°, in order that the oil may separate. The bright fluid film is then skimmed off.

Characters and Constituents.—A bright oil with a faint straw tinge, sp. gr. ·87 to ·89, becoming solid from the formation of brilliant crystalline laminæ of stearoptene when mixed with alcohol or exposed to a temperature between 60° and 68°. The attar is a mixture of odourless stearoptene, which exists in the proportion of about 18 per cent. in Turkish oil, and has the composition $C_{20}H_{40}$; and of oxygenated hydrocarbon, which is the odoriferous constituent. In the inferior oils obtained by the distillation of French and English flowers, the proportion of stearoptene forms often as much as 60 per cent., and the oil congeals at about 86°.

Adulterations.—Attar of roses is systematically adulterated in Turkey with the so-called geranium oil—the volatile oil of *Andropogon Schœnanthus*, an Indian grass; and as this hinders the crystallisation of the stearoptene, an inferior attar, *i.e.*, one containing a large proportion of stearoptene, is preferred by the Turkish sophisticators, or a little spermaceti is added to produce concretion at the proper temperature.

Uses.—Attar of roses is simply employed as a perfume, and to give a pleasant odour to lip-salve and other ointments, and to snuffs. Its solution in water is used in the following form, which is best obtained by distillation of the flowers.

3. **Aqua Rosæ**, *P.B.* *Rose Water.*

Prepared in the manner and proportions directed for elder flower water.

Pharmaceutical Uses.—A pleasant vehicle for medicines that have a mawkish taste, and as a solvent for sulphate of zinc and other salts used as lotions. It is a constituent of Mistura ferri composita and Trochisci bismuthi.'

ROSA GALLICA, *Linn.* The Red Rose.

This is a native of the southern parts of Europe, of the Caucasus, and Asia Minor. It has been variously called the French (Provins), German, and Austrian rose. It is said to have been introduced from the East into Provins near Paris, by a Crusader, in the year 1254, and it is still grown there for medicinal use. It is cultivated for the same purpose at Mitcham. This rose furnishes gardeners with a host of varieties.

Characters.—A dwarfish, stiff, short-branched bush; shoot with nearly equal uniform prickles and glandular bristles intermixed. *Leaflets* stiff, elliptical, rugose. *Flowers* several together, large, erect, with leafy bracts. *Sepals* ovate, leafy, compound. *Fruit* oblong.—*Nees von Esenb.* pl. 303; *Woodv. Med. Bot.* pl. 141.

1. **Rosæ Gallicæ petala,** *P.B. Red Rose Petals.*

The fresh and dried unexpanded petals. From plants cultivated in Britain.

Characters and Constituents.—Colour fine purplish-red, retained after drying, bitterish, feebly acid, astringent; odour roseate, developed by drying. The petals contain traces of *tannic* and *gallic acids*, a glucoside called *quercitrin*, $C_{33}H_{30}O_{17},H_2O$, a little *fat*, *glucose*, and *colouring matter.* Quercitrin is the yellow crystallisable colouring matter found in the bark of *Quercus tinctoria.* When boiled with dilute sulphuric acid it is resolved into glucose, and quercetin $C_{27}H_{18}O_{12}$, which separates from alcohol in lemon-yellow crystals. It is soluble in solutions of the caustic alkalies with the production of a golden-yellow colour. Aqueous solution of the colouring matter is deepened to a splendid crimson by the mineral or vegetable acids, and alkalies change it to a bright green.

2. **Infusum Rosæ acidum,** *P.B. Acid Infusion of Roses.*

Preparation.—Add 1 fluid drachm of dilute *sulphuric acid* to 10 ounces of *boiling water*, infuse $\frac{1}{4}$ ounce of dried *red rose petals* in the mixture for half an hour, and strain.

Action and Use.—An acid tonic and astringent. Diluted with water, it forms a pleasant, acidulous drink in febricula attendant upon internal hæmorrhage, in phthisical sweating, and generally where the use of sulphuric acid is not contraindicated.

Dose.—1 to 2 fluid ounces.

3. **Syrupus Rosæ Gallicæ,** *P.B. Syrup of Red Roses.*

Preparation.—Infuse 2 ounces of dried *red rose petals* in 1 pint of *boiling water* for two hours, squeeze through calico, heat the liquor to the boiling point, and filter. Dissolve 30 ounces of *refined sugar* in the liquor by means of heat. The product should weigh $2\frac{5}{8}$ pounds, and have the sp. gr. of 1·335.

Action and Uses.—A mild astringent, chiefly employed for flavouring and colouring medicines. Admixture with those which possess an alkaline reaction should be avoided.

4. **Mel Rosæ.** *Honey of Roses.*

This may be prepared according to the previous formula, substituting 2 pounds of clarified honey for the sugar, and boiling down to a proper consistence.

Uses.—An adjunct to gargles, and a mild application to a tender mouth.

5. **Confectio Rosæ Gallicæ,** *P.B.* *Confection of Roses.*

Preparation.—Beat 1 pound of fresh *red rose petals* to a pulp in a stone mortar, add 3 pounds of *refined sugar*, and rub them well together.

Pharmaceutical Uses.—A vehicle for the formation of pills generally, and employed in the following:—Pilula aloes Barbadensis, P. a. et assafœtidæ, P. a. et ferri, P. a. et myrrhæ, P. a. Socotrinæ, P. ferri carbonatis, P. hydrargyri, P. plumbi cum opio.

BRAYERA ANTHELMINTICA, *Kunth.* Kousso.

Bruce met with this tree on the table land of Abyssinia, where it is esteemed for its umbrageous foliage and ornamental flowers. Lamark described it in 1811, and named it after Dr Hagen of Königsberg, *Hagenia Abyssinica.* Dr Brayer of Constantinople introduced it in 1822 as a tænicide, for which purpose it has been long employed by the Abyssinians.

Characters.—A handsome *tree*, 60 feet high. *Branches* round, rusty-tomentose, marked by annular cicatrices of the fallen leaves. *Leaves* crowded, alternate, interruptedly impari-pinnate, and sheathing at the base. *Leaflets* oblong or elliptical-lanceolate acute, serrate, villose at the margin and on the nerves of the under surface; *stipules* adnate to the dilated, amplexicaul petiole. *Panicle* large, the branches regularly zigzagged. *Flowers* diœcious, small, greenish, and becoming purple; *pedicels* with an ovate bract at the base. *Male Flowers*—*Calyx* surrounded by several veined bracts, composed of 10 sepals, the outer series being the smaller. *Stamens* 10 to 25. *Female Flowers*—*Calyx* with the outer series much larger than the inner. *Petals* minute linear. *Carpels* 2, included in the tube of the calyx, each furnished with a hairy style. *Fruit* an obovate 1-seeded *nut.*—*Hooker's Journ. Bot.* 3d Ser. vol. ii. pl. 10.

1. **Cusso,** *P.B.* *Koussò.*

The flowers and tops of the plant above described, collected in Abyssinia.

Characters and Constituents.—Composed of large panicles 10 or 12 inches long, the branches of which are downy; or of flowers detached and broken. The individual flowers are small, reddish-brown, on hairy stalks, outer limb of the calyx five-parted, the segments oblong-lanceolate and veined. It has a feeble tea-like odour, and a bitterish subacrid taste.

The flowers yield 24 per cent. of *tannic acid, wax, gum, sugar,* and 6·25 per cent. of an *acrid bitter resin,* on which the particular virtues of the drug probably depend. Bedall of Munich and Merck of Darmstadt have isolated a crystalline body, *koussin* or *kosin*, to which the formula $C_{31}H_{38}O_{10}$ has been assigned (See *Hanb. and Flück. Pharmacographia*, p. 229). It may be prepared by mixing the flowers with lime, exhausting them first with alcohol, then with water, concentrating the mixed, solutions and adding acetic acid, which precipitates the koussin. The flowers yield about 3 per cent. It forms fine rhombic crystals of a yellow colour, tasteless, and insoluble in water, soluble in about 400 parts of alcohol; freely soluble in boiling alcohol, in æther, chloroform, benzol, glacial acetic acid, and solutions of the caustic and carbonated alkalies, from which it is precipitated unaltered by acids. It fuses at 288°, and forms on cooling a yellow amorphous mass, which when touched with a drop of alcohol assumes the crystalline form. Proof is wanting that this is the active constituent of the drug.

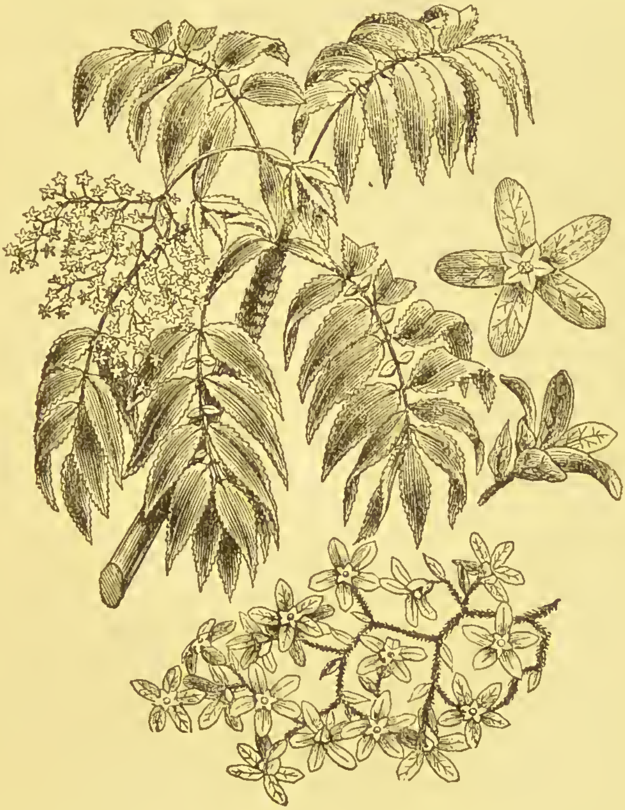

Fig. 102.—*Brayera anthelmintica.* The female flower is given on a larger scale.

Action and Uses.—Kousso is an irritant, large doses producing nausea, griping, and purging. It is said to have produced abortion in one or two cases. It is employed to expel tænia and bothriocephalus from the intestines.

Dose.—$\frac{1}{4}$ to $\frac{1}{2}$ ounce of the powdered flowers suspended in water.

Usually it is not necessary to take an aperient with the drug. If it does not act alone, a dose of castor oil may be given twelve hours after the kousso. The following is the best form of administration:—

2. **Infusum Cusso**, *P.B.* *Infusion of Kousso.*

Preparation.—Infuse ½ ounce of *kousso* in coarse powder in 8 ounces of boiling *water* for fifteen minutes. It is taken unstrained.
Dose.—4 to 8 fluid ounces.

CYDONIA VULGARIS, *Pers.* The Quince.

The Quince (κυδονία), the *Pyrus Cydonia* of Linnæus, was known to the ancients and Arabs; the seeds (*bihee dana*) are employed medicinally in India, being imported from Cabul and Cashmere, where the tree is cultivated.

Characters.—A moderately-sized, much-branched, but crooked tree. *Leaves* ovate, obtuse at the base, quite entire, with the lower surface as well as the calyx and pedicle tomentose. *Flowers* few, white or rose-coloured, in a kind of umbel. The *pomes* closed, globose or oblong, 5-celled; *cells many-seeded,* cartilaginous. *Seeds* enveloped in condensed mucilage.—*Nees von E.* 305 ; *Steph. and Church,* 114.

The fruit of the quince is pyriform, of a yellow colour, downy, and remarkable for its fine odour. The ancients used it as a medicine, but it is now chiefly employed for flavouring other fruits, or as a preserve. It contains some astringent principle, with malic acid, sugar, and azotised matter (Soubeiran). The seeds are reddish-brown, oblong, pointed, convex on the outside, and with one or two flat sides, from mutual pressure.

The epidermis consists of a single row of cylindrical cells, which are composed of condensed mucilage, for in the presence of water they swell to an enormous size and dissolve. The seed yields as much as 20 per cent. of dry *mucilage*, resembling that of linseed, and having the composition $C_{12}H_{20}O_{10}$. It is associated with a considerable amount of lime salts. It yields oxalic acid when treated with nitric acid, and, like cellulose, gives a blue colour with iodine after a short contact with sulphuric acid. It must be regarded as a soluble modification of cellulose. The kernel resembles the bitter almond in flavour.

1. **Decoctum seminum Cydoniæ.** *Decoction of Quince Seed.*

Preparation.—Boil 120 grains of the *seed* in 1 pint of *water* for ten minutes, and strain.
Action and Uses.—Those of linseed. It is quite insipid.

AMYGDALUS COMMUNIS, *Linn.* The Almond.

The Almond is mentioned in the Book of Genesis. There are two distinct varieties of the seed, the *bitter* and the *sweet* almond, a variation probably due to cultivation, and one which is not indicated by any reliable or permanent characters, excepting that just stated. Both varieties are found in the countries extending from

Syria to Affghanistan. Both were known to the ancients and to the Arabs.

Characters.—A small *tree* with lanceolate *leaves,* which are glandularly serrate, young leaves folded flat; *petioles* glandular, equal in length to, or longer than, the transverse diameter of the leaf. *Flowers* nearly sessile, solitary, appearing earlier than the leaves. Tube of the *calyx* companulate. *Fruit* a dry drupe, ovoid compressed, externally tomentose, when ripe bursting irregularly. Within this is contained a hard but brittle shell, enclosing the *kernel* or *almond.*

Var. *α, amara.* *Petioles* studded with glands. *Style* equal in length to the stamens. *Seed* bitter.

Var. *β, dulcis.* Base of the leaf and lower serratures bearing glands. *Style* much longer than the stamens. *Seed* sweet.—*Nees von Esenb.* pl. 312 and 313; *Woodv. Med. Bot.* pl. 83.

1. **Amygdala amara,** *P.B.* *Bitter Almond.*

The seed of the bitter almond tree, brought chiefly from Mogadore.

Characters and Constituents.—Scarcely an inch long, flattened, lanceolate, acute, with a clear cinnamon-brown seed-coat, a bitter taste, and when rubbed with a little water, a characteristic odour. They contain about 45 per cent. of *fixed oil,* from 5 to 10 per cent. of *sugar* and *gum,* about 24 per cent. of *albumin,* a portion of which is in a soluble state forming *emulsin,* from 2½ to per cent. of *amygdalin* $C_{20}H_{27}NO_{11}$, and nearly 5 per cent. of inorganic salts, chiefly composed of the phosphates of potash, lime, and magnesia.

The aqueous distillate of bitter almonds contains hydrocyanic acid and benzoyl hydride (essential oil of bitter almonds). These bodies, however, do not pre-exist in the seed, but are formed by the action of emulsin on amygdalin in the presence of water, amygdalin breaking up into prussic acid, essential oil, glucose, formic acid, and water, thus:—$2C_{20}H_{27}NO_{11} = 2HCy + 4C_7H_6O + C_6H_{12}O_6 + 4HCHO_2 + 4H_2O$. 100 parts of amygdalin yield about 41 of essential oil of bitter almonds and 6 of hydrocyanic acid.

If the amygdalin be previously separated from the seed, or if the emulsin be coagulated, this reaction does not occur.

Amygdalin is obtained by boiling the cake left after the expression of the fixed oil in alcohol of sp. gr. ·825, the alcohol is distilled off, any sugar destroyed by fermentation with yeast, and the filtered solution concentrated when the amygdalin crystallises in tufts of needle-like prisms. It is soluble in 15 parts of water, forming a permanent neutral, inodorous, and innocuous solution; but if a little emulsin of sweet almonds be added, decomposition immediately occurs, indicated by the development of the odour of oil of bitter almonds. 17 grains of amygdalin mixed with 1 ounce of emulsion of sweet almonds, furnishes 1 grain of pure hydrocyanic acid = 50 minims of the dilute acid of the Pharmacopœia.

Under the influence of oxydising agents, amygdalin is resolved into benzoyl hydride, benzoic acid, formic acid, and ammonia, thus:—$C_{20}H_{27}NO_{11} + O_4 = C_7H_6O + HC_7H_5O_2 + 6HCHO_2 + H_3N$.

Emulsin or synaptase is also extracted from the cake after the expression of the fixed oil. The cake is mixed with thrice its weight of cold water, strained, and left at 70° to 80° for three or four days, then the coagulum (vegetable casein) is separated from the whey, and when this ceases to precipitate with acetic acid the emulsin is precipitated by the addition of alcohol. It falls in combination with the earthy phosphates which do not interfere with its action. The precipitate is washed with absolute alcohol, and dried in vacuo over sulphuric acid. It is wholly soluble in cold water, and the solution has an acid reaction, which enables it to hold the earthy phosphates in solution.

Action and Uses.—Owing to the formation of hydrocyanic acid by the process above explained, the bitter almond is highly poisonous. An emulsion is sometimes prescribed as a means of giving hydrocyanic acid, but as the amount of amygdalin is variable, this practice must be condemned. The effects of the ingestion of the seed are those of hydrocyanic acid, and they have proved fatal in many cases.

2. **Oil of Bitter Almonds or Benzoyl Hydride.** $C_7H_5O,H = 106$.

This is prepared by mixing the crushed almond cake from which the fixed oil has been expressed into a creamy fluid by the addition of *cold* water. The mixture is allowed to stand in the still for twenty-four hours, to give time for the emulsin to completely decompose the amygdalin. It is then distilled so long as the distillate is milky-turbid. The yield of oil is about 1 per cent., but the crude oil contains hydrocyanic and benzoic acids, and a little benzoine, $C_{14}H_{12}O_2$. The former of these constituents exists in the proportion of from 8·5 to 14·33 per cent., and renders the oil extremely poisonous; it may be separated by agitating the oil with a mixture of milk of lime and ferrous chloride, and then redistilling. The pure oil is not poisonous, is colourless, of sp. gr. 1·049, boils at 356°, is inflammable, has the agreeable odour of bruised peach leaves, is soluble in 30 parts of water; and when exposed to the air absorbs, like an aldehyd, 2 atoms of oxygen, and is converted into a crystalline mass of benzoic acid, $2C_7H_6O + O_2 = 2HC_7H_5O_2$. Heated with caustic potash hydrogen is liberated, and benzoate of potash formed. Dilute nitric acid converts it into nitro-benzoyl, C_7H_5O,NO_2.

Action and Uses.—The pure oil is no doubt converted into benzoic acid in the body, and would have the same effects. Granting this, it must previously exercise a deoxydising action on the blood. The oil is much employed as a flavour and perfume, and if pure, is quite harmless; but the impure oil has been the frequent cause of serious and fatal accidents.

3. **Oleum Amygdalæ,** *P.B.* *Almond Oil.*

The oil expressed from bitter and sweet almonds.

Characters and Constituents.—A thin, pale yellow oil of sp. gr. ·92; nearly inodorous, or having a nutty flavour with a bland oleaginous taste. It does not solidify until reduced to about 13°. It becomes rancid by exposure to the air, but does not dry.

It consists almost entirely of olein (see p. 242).

Action and Uses.—Those of olive oil. Owing to its greater fluidity, it is preferred to olive oil for dropping into the ears in order to loosen and dissolve the wax.

Pharmaceutical Uses.—A constituent of Ungentum cetacei, U. hydrargyri oxydi rubri, U. plumbi subacetatis compositum, U. simplicis and the preparations containing it.

4. **Amygdala dulcis,** *P.B.* *Sweet Almond.*

The seed of the sweet almond, cultivated about Malaga.

Characters and Constituents.—Slightly longer and narrower than the bitter almond, of a bland, sweetish, nutty flavour, not evolving the odour or flavour of bitter almonds when bruised with water, or masticated.

The constituents are the same as those of the bitter almond, except that it does not contain amygdalin. The quantity of fixed oil is rather greater than that of the bitter almond, being about 50 per cent. The quantity of sugar sometimes reaches 10 per cent.

Action and Uses.—The sweet almond is highly nutritious, and readily furnishes an emulsion for the suspension of certain insoluble medicines. Almond cake is made into biscuits for the use of diabetic patients, when it is thought desirable to exclude starch from the diet.

Pharmaceutical Uses.—In the expression of Oleum amygdalæ, and in the preparation of the following:—

5. **Pulvis Amygdalæ compositus,** *P.B.* *Compound Almond Powder.*

Preparation.—Steep 8 ounces of *sweet almonds* in warm water until their skins can can be easily removed; and when this has been effected, dry them thoroughly with a soft cloth and rub them lightly in a mortar to a smooth consistence; add gradually 4 ounces of *refined sugar* in powder, and 1 ounce of *gum acacia* in powder, rub the whole to a coarse powder, and keep it in a lightly covered jar.

Use.—It is employed for the extemporaneous preparation of the following:—

6. **Mistura Amygdalæ,** *P.B.* *Almond Mixture.*

Preparation.—Rub 2½ ounces of compound *almond powder* with a little *water* into a thin paste, then add gradually sufficient water to make a pint of the mixture, and strain through muslin.

Uses.—A pleasant vehicle for many medicines, such as alkalies, and insoluble salts, as subnitrate of bismuth. It is demulcent and nitritious.

Dose.—1 to 2 fluid ounces.

PRUNUS DOMESTICA, *Linn.* The Plum.

The common Plum-tree is supposed to be the *κοκυμηλέα* of Dioscorides; but this may have been *Prunus Coccomilla* of Tenore, a native of Calabria, a species which is supposed by some to be the original of the former. Damascus prunes (*Pruna Damascena*) are often mentioned in the writings of the Greek physicians.

Greece, the south-eastern shores of the Black Sea, the Caucasus, and Northern Persia appear to be the native habitats of the plum-tree. The variety *Juliana*, Decand. (*Prunier de St Julien*), cultivated in the valley of the Loire, is the source of the French prunes of commerce. Many other varieties are cultivated in the gardens of Europe.

Characters.—1. var. *Juliana,* Decand. A small *tree* with smooth branches and elliptical *leaves.* *Flower buds* formed of one or two flowers. *Petals* white, oblong-ovate. *Drupe* ovate-oblong, deep purple, not depressed at the insertion of the stalk, with a scarcely visible suture and no furrow, pulp greenish and rather austere. *Stone* about $\frac{3}{4}$ long by $\frac{1}{2}$ inch broad, rounded at the superior end, narrowed and truncate at the lower, the ventral suture wider and thicker than the dorsal.—*Woodv. Med. Bot.* pl. 85.

2. Var. *Pruneauliana,* Decand. (*P. œconomica,* Borkhausen). The *Quetschen,* or German prune, is the produce of this variety. It is rather larger than the French prune, and the stone is flatter, narrower, pointed at both ends, and the ventral suture is more curved than the dorsal.

1. **Prunum,** *P.B.* *Prune.*

The dried drupe of the plum above described. From Southern Europe.

The fruit is exposed alternately to the heat of an oven and to the open air. Thus preserved, it is about $1\frac{1}{4}$ inch long, ovate, black, shrivelled, containing a tough brown mucilaginous, and sweetly acidulous pulp. It contains about 25 per cent. of *saccharine matter,* free *malic acid,* a large quantity of *gum* and *pectin,* and some *calcium oxalate.*

Action and Uses.—Nutritious, demulcent, and laxative. Stewed prunes are very useful articles of diet when there is habitual constipation. The pulp forms about $\frac{1}{12}$ part of Confectio sennæ.

PRUNUS LAUROCERASUS, *Linn.* The Common or Cherry Laurel.

This shrub, so common in every garden in England, is a native of Asia Minor, especially near Trebizond, whence it was introduced into Europe by Clusius about 1576. It is commonly called "Laurel," but must not be confounded with the true Laurel or Bay (see p. 450). It must also be distinguished from the Portugal laurel, *P. Lusitanica.*

Characters.—A small *tree,* or smooth evergreen *shrub.* *Leaves* coriaceous, oblong, acuminate, remotely serrated, shining on the upper surface, with 2 or 4 glands beneath. *Racemes* simple, axillary, about the length of the leaves. *Petals* white, roundish, spreading. *Stamens* 20. *Drupe* destitute of bloom, elliptical, black, about the size of the Bay berry.—*Nees von E.* 317 ; *Steph. and Church,* pl. 117.

1. **Laurocerasi folia,** *P.B.* *Cherry-Laurel Leaves.*

The fresh leaves.

Characters and Constituents.—Ovate-lanceolate or elliptical, on strong short foot-stalks; margin recurved, and slightly and distinctly toothed, with 2 to 4 shallow glands on the under surface at the base, deep green, of leathery consistence, smooth and shining; emitting a ratafia odour when bruised.

The leaves contain amygdalin, emulsin or an albuminoid substance readily converted into emulsin, sugar, fat, and a small quantity of tannic acid. When distilled with water, they yield oil of bitter almonds and hydrocyanic acid, the proportion varying according to the time of the year, being half as much in winter as in July and August (Broeker). According to Sir R. Christison, the buds and unexpanded young leaves in May or June yield 6·33 grs. of volatile oil in 1000, but that the proportion sinks to 3·1 grs. in July, and goes on gradually diminishing to only 0·6 in the subsequent May, when they are twelve months old, and when the new unexpanded leaves of the same plant give ten times as much.

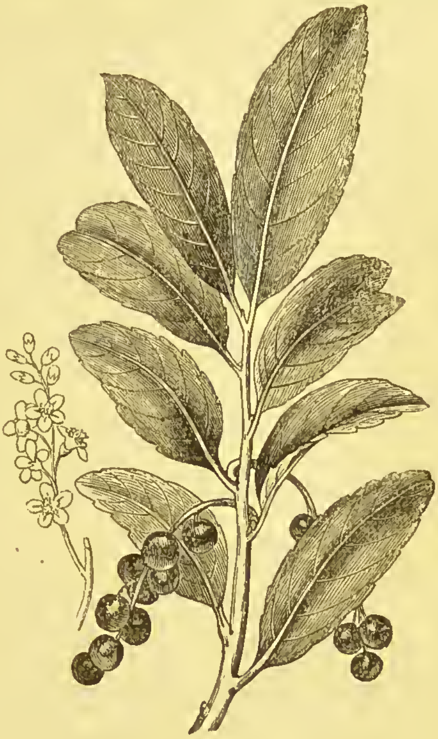
Fig. 103.—*Prunus Laurocerasus.*

2. Aqua Laurocerasi, *P.B.* *Laurel Water.*

Preparation.—Chop 1 pound of the *fresh leaves*, crush them in a mortar, and macerate them in 2½ pints of *water* for twenty-four hours, then distil 1 pint of liquid. Shake the product, filter through paper, and preserve it in a stoppered bottle.

The maceration allows of the solution and reaction of the amygdalin and emulsin. The result of distillation is a saturated aqueous solution of oil of bitter almonds, containing a quantity of hydrocyanic acid, that may be 10 or 15 times greater under some conditions than it is under certain others. If the Pharmacopœia had provided against the variation resulting from the age of the leaf and season, the inconsistency which, on the one hand, recklessly prescribes a solution of prussic acid of unascertained, and after all precautions have been taken, variable strength; and on the other, gives the most scrupulous directions for the preparation of a 2 per cent. solution of the same acid, would still be grossly apparent. Nor can it be argued that laurel water, as prepared above, is intended to meet an emergency which may arise where the conveniences of life are inacessible, for a convincing answer, in the shape of a retort, lies in the way.

Action and Uses.—Those of hydrocyanic acid.

Dose.—5 to 30 minims.

OTHER MEDICINAL SPECIES OF PRUNUS.—The inner bark of the root and branches of the wild cherry (*P.* or *Cerasus Padus*), and *P.* or *Cerasus Virginiana* of Miller, and *C. serotina* of Linn., have been recommended from time to time as sedative and tonic. They contain *amygdalin* and *emulsin*, and therefore furnish the sedative principle hydrocyanic acid with cold water; they also contain *tannic acid* and a *bitter extractive*, to which it appears their tonic effect is due. The bark of the last mentioned plant, under the name "Cortex pruni serotinæ," is an article of the United States Pharmacopœia. It is prescribed in doses of 30 to 40 grains in intermittent fevers and in phthisis. The infusion (½ to 16 ounces) made with boiling water which coagulates the emulsin, is simply tonic in doses of 1 to 2 ounces. The astringent juice of *P. spinosa*, the Sloe or Bullace, inspissated, is substituted for the ancient *akakia* (p. 638).

LEGUMINOSÆ, *Jussieu.* The Pea Family.

Like the Rosaceæ, this order naturally forms three distinct sub-orders,—the *Papilioneæ*, in which the corolla is papilionaceous, and the definite stamens mono- or diadelphous; the *Cæsalpinieæ*, in which the corolla loses its papilionaceous character, but is still a little irregular occasionally, and always imbricated in æstivation, and the stamens are definite and distinct; and the *Mimoseæ*, characterised by a regular valvate corolla and indefinite hypogynous stamens. The chief characteristic of the order—the leguminous fruit—is maintained throughout the family. The medicinal properties of this important order are fully illustrated in the various products furnished by the following numerous plants. Besides these medicinal products, the order furnishes peas, beans, vetches, clover, and other valuable food for man and the domestic animals.

MYROXYLON PEREIRÆ, *Klotzsch.* **The Balsam of Peru Tree.**

A lofty tree, growing on the balsam coast of Salvador, between the 13° 35′ and 14° 10′ N. latitude. It is naturalised in Ceylon.

Characters.—*Branches* smooth but warty, ash-coloured. *Leaves* imparipinnate; *leaflets* 5–11, alternate, oval-oblong, abruptly acuminate, emarginate. *Racemes* loose, 6–7 inches long. *Fruit* 1-celled, 1-seeded, winged, indehiscent, unequal-sided, pod narrowed at the base, fruit-stalk winged above, with the pod about 3¼ inches long; mesocarp fibrous, the inner part with receptacles of oleo-resin. *Seeds* loose, cotyledons yellowish, oily, of an agreeable odour.—*Pharm. Journ.* vol. x. 1st series, p. 282.

The wood contains a liquid balsam, which is obtained by previously bruising portions of the bark with the back of an axe, so as to promote its separation, and five or six days afterwards charring it by torches or burning wood, to excite the flow of balsam. A week afterwards the bark drops off, or may be easily removed, and the stem begins to exude balsam. It is allowed to soak into rags inserted in the apertures; these are afterwards boiled in water, and the balsam is skimmed off the surface. This, the *Balsamo negro*, has to be strained before it is fit for exportatation. The whole average annual yield is stated to be about 25,000 lb. A semi-solid substance, called *Balsamo blanco*, or White Balsam, is obtained by expression of the seeds and inner portion of the fruit of the same tree. It has been confounded with Tolu Balsam, but is quite distinct from it, and without its peculiar odour. Besides these two products, a fragrant liquid, called *Balsamito*, in high repute throughout Central America as a stimulant and vulnerary, is prepared by digesting in rum the inner part of the fruit of this Myrospermum.

1. **Balsamum Peruvianum,** *P.B.* *Balsum of Peru.* F. *Baume de Perou.* G. *Perubalsam.*

A balsam obtained from the tree above described, by exudation from the trunk after the bark has been scorched and removed. From Salvador in Central America. It formerly came to Europe through Peru, and so obtained its specific name.

Characters and Constituents.—A reddish-brown or nearly black liquid, sp. gr. 1·15, translucent in thin films; having the consistence of syrup, a balsamic odour, and an acrid slightly bitter taste. Soluble in 5 parts of rectified spirit. Undergoes no diminution in volume when mixed with water, but yields to it traces of cinnamic and benzoic acids.

It is composed of 38 per cent. of black, odourless, tasteless, amorphous *resin*, soluble in alcohol and caustic alkalies, and furnishing by destructive distillation benzoic acid, toluol C_7H_8, and styrol C_8H_8; the remainder, about 60 per cent., is *cinnamein* or *benzylic cinnamate* $C_{16}H_{14}O_2$, a brownish aromatic liquid, sp, gr. 1·1, it volatilises unchanged at about 570°, is soluble in carbon bisulphide, and is resolved by the caustic alkalies into cinnamic acid $C_9H_8O_2$, and benzylic alcohol C_7H_8O.

Action and Uses.—A stimulant to the mucous membranes, and useful as an expectorant in chronic bronchitis. It is also used as a stimulant application to indolent ulcers.

Dose.—10 to 15 minims, on sugar, or in the form of emulsion.

MYROXYLON TOLUIFERA, *H.B.K.* The Balsam of Tolu Tree.

A lofty evergreen tree, resembling the preceding species; a native of Venezuela and New Granada, and the *Myrospermum toluiferum* of A. Richard.

Characters.—*Branches* smooth, warty. *Leaflets* 7–8, ovate-oblong, acuminate, rachis smooth. *Calyx* campanulate, 5-toothed. *Petals*, the upper one largest. *Stamens* 10, free. *Ovary* stalked, oblong, membranous, 2-6 ovules. *Style* filiform, lateral. *Legume* indehiscent, oblique, with winged expansions very broad at the apex, and a winged stalk.

The wood contains a liquid balsam, which is obtained by making a number of V-shaped incisions through the bark and young wood, and fixing a calabash about the size of a tea-cup under the apex formed by the convergent incisions. As many as twenty calabashes may be seen attached to the same stem, and the bleeding goes on for eight months of the year. (Weir, *Jour. Roy. Hort. Soc.* May 1864.) In some districts the balsam is allowed to flow down the trunk into a large leaf.

1. **Balsamum Tolutanum,** *P.B.* *Balsam of Tolu.* F. *Baume de Tolu.* G. *Tolubalsam.*

A balsam obtained from the tree above described, by exudation after incisions of the bark. From New Granada.

Characters and Constituents.—A soft and tenacious solid, with a fragrant balsamic odour, light brown colour, and feebly aromatic taste. After very long exposure to the air it becomes brittle below 40°. If a thin layer be examined by the microscope it is seen to be filled with crystals of cinnamic acid. It is insoluble in bisulphide of carbon, which dissolves so considerable a portion of balsam of Peru, but is freely and completely soluble in alcohol, chloroform, and glacial acetic acid. Boiling water dissolves out cinnamic acid.

The balsam is composed of amorphous *resin*, apparently identical with that of balsam of Peru. Of a large proportion of *cinnamic acid* (see p. 457), and of about 1 per cent. of *tolene*, $C_{10}H_{16}$, a volatile oil obtained by distilling the balsam with water. By destructive distillation it yields the same compounds as balsam of Peru under similar treatment, and also a little phenol and styrol.

Action and Uses.—Those of balsam of Peru, in addition to which it is used to give an agreeable odour to lip-salve, and a pleasant taste to certain medicines.

Dose.—10 to 20 grains.

Pharmaceutical Uses.—A constituent of Tinctura benzoini composita and the two following articles:—

2. **Syrupus Tolutanus,** *P.B.* *Syrup of Tolu.*

Preparation.—Boil 1¼ ounce of *balsam of Tolu* in 1 pint of *water* for half an hour in a lightly covered vessel, stirring occasionally. Remove from the fire, and add water if necessary that the liquid may measure 16 fluid ounces. When cold filter, add 2 pounds of *refined sugar*, and dissolve with the air of a steam or water bath. The product should weigh 3 pounds, and have the sp. gr. 1·33.

Dose.—1 fluid drachm. A pleasant and helpful adjunct to a cough linctus.

3. **Tinctura Tolutana,** *P.B.* *Tincture of Tolu.*

Contains 54½ grains of balsam in 1 fluid ounce.

Preparation.—Macerate 2½ ounces of *balsam of Tolu* in 15 fluid ounces of *rectified spirits,* with occasional agitation, for six hours, or until the balsam is dissolved; then filter, and add sufficient rectified spirit to make 1 pint.

Dose.—20 to 40 minums.

Pharmaceutical Uses.—In the preparation of Trochisci acidi tannici, T. morphiæ, T. morphiæ et ipecacuanhæ, and T. opii.

COPAIFERA, SPECIES VARIÆ. Copaiba Trees.

These are lofty forest trees, natives of Central America as far south as Bahia.

Generic Characters.—*Leaves* alternate, pinnate. *Leaflets* coriaceous, somewhat unequal, ovate. *Flowers* in compound axillary and terminal spikes. *Calyx* ebractiolate, of 4 small, equal, spreading sepals, united at the base. *Petals* 0. *Stamens* 10, distinct, nearly equal, declinate. *Ovary* free, with 2 ovules. *Style* filiform. *Legume* stalked, obliquely elliptical, coriaceous, a little compressed, 2-valved, 1-seeded. *Seed* elliptical, enclosed in a 1-sided aril. *Embryo* straight.

1. C. MULTIJUGA, Hayne.—*Leaflets* 6 to 10 pairs, unequal sided, acuminate, with pellucid dots. *Habitat.*—Para.

2. C. LANGSDORFII, Desf.—*Leaflets* 3 to 5 pairs, oval, blunt, equal sided, with pellucid dots. *Petioles* and *peduncles* slightly downy. Fig. 104. *Habitat.*—Santa Paulo.

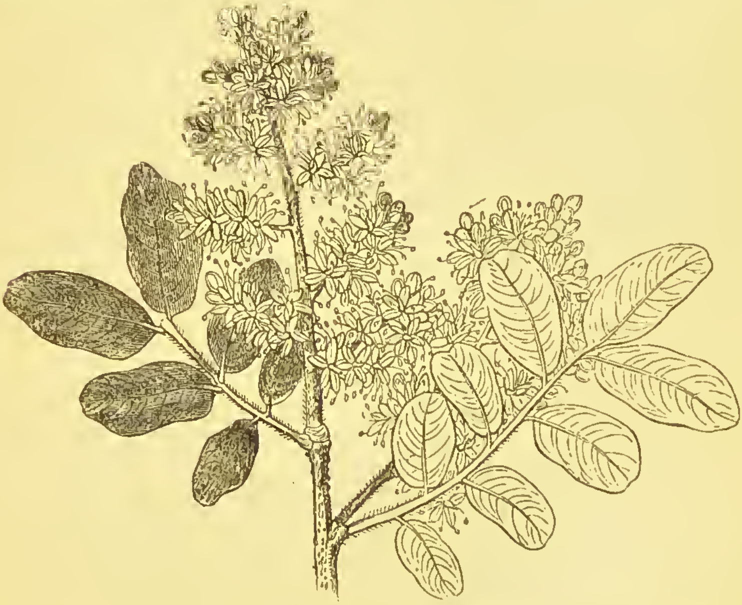

Fig. 104.—*Copaifera Langsdorfii.*

3. C. OFFICINALIS, Linn., or C. JACQUINI, Desf.—*Leaflets* 2 to 5 pairs, incurved, ovate, obtusely acuminate, with pellucid dots, unequal sided. *Habitat.*—Venezuela, West Indies.

4. C. CORIACEA, Mart.—*Leaflets* 2 to 3 pairs, elliptical, equal sided, emarginate, coriaceous, not dotted. *Habitat.*—Santa Paulo, Bahia.

The wood of these trees is replete with oleo-resin, sometimes even to bursting. It is obtained by cutting or boring to the heart of the tree near its base. Usually the balsam flows so rapidly from this wound that many pounds may be collected in a few hours.

1. **Copaiba**, *P.B.* *Copaiva.*

The oleo-resin obtained from incisions made in the trunk of *Copaifera multijuga* and other species of Copaifera, chiefly from the valley of the Amazon.

Characters, Composition, and Tests.—About the consistence of olive oil; sp. gr. 0·940 to 0·99; pale or golden yellow, transparent, of a peculiar aromatic odour, and a persistent aromatic acrid bitterish taste. Perfectly soluble in an equal volume of benzol. Does not become glutinous after having been heated to 270° (absence of Gurjun balsam, which see). Is not fluorescent. It is miscible in all proportions with absolute alcohol, acetone, and bisulphide of carbon, and dissolves ¼ its weight of carbonate of magnesia by the aid of heat and remains transparent. It is like the fluid turpentine of the coniferæ, a solution of *resin* in *volatile oil*, which constitutes from 40 to 60 per cent. (see Oil of Copaiba). The resin is amorphous and acid. When heated with solution of ammonia crystalline *copaivic acid* $C_{20}H_{32}O_2$, is formed. Sometimes copaiba spontaneously deposits crystals of *oxycopaivic acid* $C_{20}H_{28}O_3$, and *metacopaibic acid* $C_{22}H_{34}O_4$, may be extracted from some samples of balsam by means of alkali. These resin acids are bitterish, and form crystalline salts with bases. The resin itself yields only amorphous salts.

Adulterations.—These are (1) *castor*, or other *fixed oil;* (2) *Gurjun balsam* or *wood oil.* The admixture with fixed oil may be detected by prolonged boiling with water, so as to drive off the volatile oil of copaiba; the remaining resin is greasy. Castor oil is detected by heating 1 part of the oleo-resin with 4 parts of rectified spirit. On cooling the mixture separates into two layers, and on separation and evaporation of the upper, which contains the volatile oil, castor oil will remain. Gurjun balsam is recognised by a test given above.

Action and Uses.—In large doses, it is irritant to the mucous membrane, causing nausea, and even vomiting, griping, and purging; in moderate doses it is stimulant to the skin and mucous membrane. It is partially eliminated by the skin and kidneys, and in the act it occasionally produces a specific erythema or urticaria, and sometimes strangury and hæmaturia. The urine is frequently turbid from the presence of an excessive quantity of mucus, and there is some irritation of the urethra and diuresis. It is said to be eliminated by the lungs also, but the evidence, as adduced by the odour of the breath, is fallacious. Such being the action of the drug its use may be readily inferred. It is given in gonorrhœa, leucorrhœa, cystitis, bronchorrhœa, and in chronic skin diseases, especially leprosy and psoriasis. In gonorrhœa and cystitis it should not be given until the acute inflammatory symptoms have subsided, or it may intensify or even produce chordee and strangury. It is very serviceable in gleet and chronic cystitis. In the treatment of chronic catarrh of the mucous membrane it is undoubtedly the most active and efficient of all the balsams and oleo-resins.

Dose.—½ to 1 fluid drachm as an emulsion flavoured with caraway or cinnamon, or enclosed in gelatine capsules.

2. **Oleum Copaibæ**, *P.B.* $C_{10}H_{16}$. *Oil of Copaiva.*

It is prepared by subjecting *copaiba* to distillation with *water.*

Characters.—A volatile oil, isomeric with oil of turpentine; sp.

gr. 0·88 to 0·9, colourless or pale yellow, with a strong odour and taste of copaiva. Miscible in all proportions, with æther, and dissolves in about 8 parts of rectified spirit. It dissolves sulphur, phosphorus, and iodine, and boils at about 475°.

Action and Uses.—Those of the oleo-resin, of which it is the essential constituent.

Dose.—5 to 20 minims. It may be dropped on to a teaspoonful of powdered sugar, and then stirred with a wineglassful of milk or orange wine.

ASTRAGALUS, SPECIES VARIÆ. Tragacanth Bushes.

These are small, tangled, spiny bushes, resembling stunted varieties of our common furze in compact hemispherical growth and the conversion of their petioles into long spines.

The species, according to Boissier (*Flora Orientalis*, ii. 1872) and others, are as follows:—

A. VERUS, Olliv.—(*A. adscendens,* Bois et Haussk., *A. brachycalyx,* Fisch). From 3 to 4 feet high. *Leaflets* 8 to 9 pairs, linear, hispid. *Flowers* papilionaceous, yellow, in axillary clusters of 2 to 5, sub-sessile. *Calyx* tomentose, 5-toothed. *Keel* of corolla obtuse. *Stamens* 10, diadelphous. *Legume* 2-celled, or partially so from inversion of the sutures.—*Oliv. Voy.* 3 t. 44; *Nees von Esen.* pl. 329. *Habitat.*—Anatolia, Armenia, mountains of Persia, attaining an elevation of 10,000 feet; Persian Kurdistan. It yields abundance of gum, which is exported to Europe and India.—*Woodv. Med. Bot.* pl. 149.

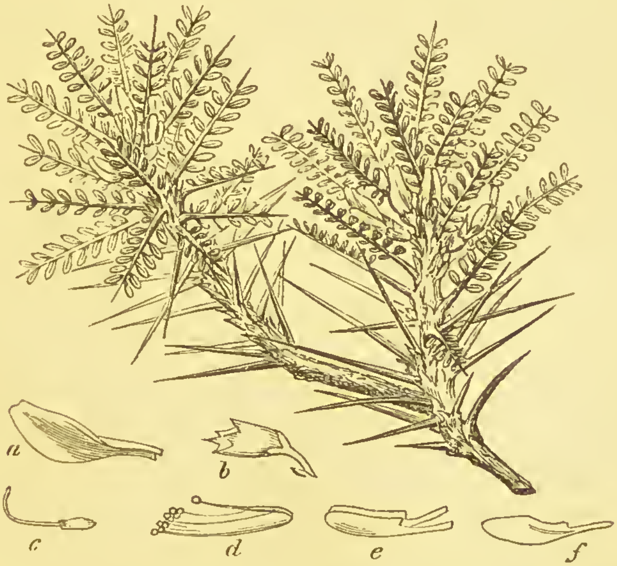

Fig. 105.—*Astragalus verus.* *b*, calyx; *a*, standard; *f*, ala; *e*, keel; *d*. stamens; *c*, pistil.

A. GUMMIFER, Labil.—*Leaflets* 5 to 6 pairs, oblong, linear, smooth. *Calyx* and *legume* tomentose. *Habitat.*—Armenia, Northern Kurdistan, Lebanon, Hermon, and mountains in Central Asia Minor.

A. MICROCEPHALUS, Willd., resembles the preceding, and is distributed throughout the same localities.

A. PYCNOCLADUS, Bois et Haussk.—A Persian species allied to the preceding.

A. STROMATODES, Bunge.—Found at an elevation of 5000 feet on the Akker Dagh range in Northern Syria.

A. KURDICUS, Bois.—A species inhabiting the mountains of Cappadocia and Cilicia.

A. CYLLENEUS, Bois and Heldr.—Found abundantly on the northern mountains of Morea.

A. CRETICUS, Lam.—*Flowers* axillary, sessile, aggregate. *Calyx* 5-partite with feathery setaceous lobes rather larger than the corolla. *Leaflets* 5 to 8 pairs, oblong, acute, tomentose. Mount Ida in Crete, where it yields a little tragacanth.

A. ARISTATUS, L'Her.—*Peduncles* very short, usually 6-flowered; calycine *teeth* long and setaceous. *Leaves* with 6–9 pairs of oblong, linear, mucronate, pilose leaflets. *Legumes* scarcely half bilocular. A native of the Alps of Europe, also of Greece. Sibthorp stated that this species yielded a gum called *τρανοχάνδα* in Greece, which was exported to Italy. Landerer has lately ascertained that tragacanth is yielded by this species on the hills near Patras, and exported to Venice and Trieste, or as Levant tragacanth to Marseilles and Ancona.

Tragacanth exudes from the above plants either naturally, or from wounds, and hardens in various forms. It is imported into this country from Smyrna, the Levant, and rarely from Greece. According to Maltass, much of the tragacanth of commerce is obtained in Anatolia, especially in the neighbourhood of Caissar (the ancient Cæsarea). The best or flaky specimens are obtained by incising the bark close to the ground in July. During the next three or four days the gum exudes, and dries in flakes. The shepherds meanwhile collect the inferior kind, which has exuded spontaneously.

1. **Tragacantha**, *P.B.* *Tragacanth.*

A gummy exudation from the stem of *Astragalus verus* and other species, collected in Asia Minor.

Characters and Constituents.—White or yellowish-white, in broad, slightly curved plates with parallel ridges, somewhat resembling fragments of an oyster shell, but tough, horny, and elastic. Dried at 120° it loses about 14 per cent. of water, and is rendered pulverisable. Very sparingly soluble in water, but swelling into a gelatinous mass which may be readily diffused through the water. The fluid portion separated by a filter is precipitated by alcohol and oxalate of ammonia, like a solution of gum acacia, but it is not rendered turbid by silicate of potash, borax, or perchloride of iron, and is precipitated by normal acetate of lead. The residue on the filter is a non-adhesive mucilage which dries into a coherent mass. Both residue and filtrate is coloured by solution of iodine. It thus appears that tragacanth is composed of a soluble gum differing in some of its reactions from arabin, and of insoluble gum. The former is called *tragacanthin*, the latter is *bassorin* $x(C_6H_{10}O_5)$. Tragacanth also contains a little starch, and yields about 3 per cent. of ash, composed chiefly of calcic carbonate. Bassorin is a widely diffused substance; it differs from arabin in the absence of acid properties, but is otherwise very closely allied to it, and is like it converted into soluble gum by the action of alkalies, into mucic and oxalic acids by nitric acid, and into sugar by prolonged boiling with dilute sulphuric acid.

Adulterations.—According to Mr Maltass, the tragacanth collected in Asia Minor commonly undergoes admixture with two other kinds of gum, called *Caramania* and *Moussal* gum. The first comes to Smyrna from the province of the same name; it is supposed to be produced by *A. gummifer.* It is darkish-coloured, and is sometimes fraudulently whitened with carbonate of lead. The *Moussal* gum comes from Armenia.

Action.—Emollient and demulcent (see Gum acacia).

Pharmaceutical Uses.—In the preparation of the following:—

2. **Mucilago Tragacanthæ,** *P.B. Mucilage of Tragacanth.*

Preparation.—To 10 ounces of *water* contained in a pint bottle add 60 grains of *tragacanth* in powder; agitate briskly for a few minutes, and again at short intervals until the tragacanth is perfectly diffused to form an uniform mucilage.

Pharmaceutical Uses.—A means of suspending heavy insoluble powders in water, and an aid in forming pills and boluses.

3. **Pulvis Tragacanthæ compositus,** *P.B. Compound Tragacanth Powder.*

Preparation.—Rub together 1 ounce each of *tragacanth, gum acacia,* and *starch,* all in powder, and 3 ounces of *refined sugar* in powder.

Uses.—It forms a demulcent linctus when mixed with water, and is a useful vehicle for the administration of heavy insoluble powders.

MUCUNA PRURIENS. The Kiwach or Cowhage Plant.

This (*Dolichos pruriens,* Linn., *Stizolobium pruriens,* Pers., and *Mucuna prurita,* Hook.) is a lofty climber, called by old Parkinson, "The Hairy Kidney-Beane." It is indigenous in the tropical regions of Africa, India, and America.

Characters.—*Stem* twining, herbaceous. *Leaves* trifoliate; leaflets oblique based, hairy beneath, acute. *Racemes* 1 to 1½ foot long, lax. *Flowers* with a disagreeable garlic odour; standard flesh-coloured, wings purple or violet; *keel* greenish-white. *Calyx* hairy, pink with lanceolate segments. *Legume* the size and shape of that of a large garden pea, with a firm rich brown pericarp, each valve with a prominent ridge, densely covered with strong, stiff, simple, sharp-pointed hairs. *Seeds* smooth, 4 to 6.—*Bot. Reg.* 1838, t. 18; *Steph. and Church,* plate 179; *Hooker, Bot. Misc.* ii. 348, *Supp.* t. 13.

The pods of the Kiwach, when young and tender, form articles of diet in India. When ripe, they are of a brownish colour and covered with innumerable fine needle-like hairs, which penetrate the skin and cause intolerable itching. The name "cow-itch" given to these hairs is a vulgar corruption of the Hindustani, Kiwach, and has no etymological connection with it.

Action. Uses.—A mechanical anthelmintic. Useful in expelling lumbrici and ascarides. The hairs, by sticking into the bodies of these worms when pressed against the intestinal parietes, irritate and thus dislodge them.

Dose.—The pods being dipped into treacle or honey, have the hairs scraped off until the mass has the consistency of an electuary, of which a tablespoonful may be given to adults, or a teaspoonful to children. It should be followed by a dose of castor oil.

GLYCYRRHIZA GLABRA, *Linn.* The Liquorice.

A perennial herbaceous plant. Native of the south of Europe and the northern parts of Syria. It is cultivated at Mitcham, and in Yorkshire.

Characters.—*Plant* 4–5 feet high. *Root* round, 3 or 4 feet long. *Leaves* imparipinnate; *leaflets* about 13, oval, slightly emarginate, viscid beneath. *Racemes* axillary, erect, shorter than the leaves. *Flowers* distant, pale blue. *Keel* of 2 petals, straight, acute. *Stamens* 10, diadelphous. *Legume* ovate compressed.—*Steph. and Church, Med. Bot.* plate 134; *Woodv. Med. Bot.* pl. 152 (*Liquiritia officinalis*); *Nees von Esenb.* pl. 327.

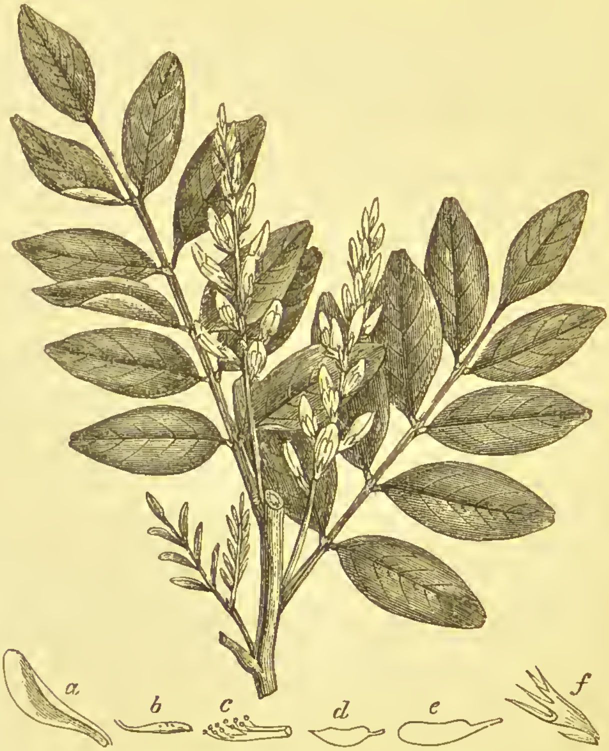

Fig. 106.—*Glycyrrhiza glabra.*
f, calx; *a*. standard; *b*, keel; *e*, ala; *c*, stamens; *d*, ovary.

The following species also furnishes liquorice. It is probably that referred to by Dioscorides.

G. echinata, Linn.—*Leaflets* oval, lanceolate, mucronate, glabrous. *Stipules* oblong, lanceolate, *Flowers* capitate, on very short peduncles. *Legumes* oval, mucronate, 2-seeded, bristly. This plant is sometimes called Russian Liquorice. It is found in Greece and Southern Russia, extending, it is said, into Tartary and Northern China.—*Sim's Bot. Mag.* 252; *Nees*, 328.

Liquorice root, *jeeteemudh*, is imported into India from Affghanistan. The species may or may not be distinct from the preceding.

1. **Glycyrrhizæ radix**, *P.B.* *Liquorice Root.*

The root or underground stem, fresh and dried, of the *Glycyrrhiza glabra.* Cultivated in England.

Characters and Constituents.—In long cylindrical branched pieces, an inch or less in diameter, tough and pliable; of a yellowish-brown colour externally, yellow internally, odourless, of a sweet mucilaginous, and slightly acrid taste. Digested with water, it yields a solution which gives a precipitate (glycyrrhizin) with diluted sulphuric acid.

The roots consist of lignin, starch, albumen, wax, *asparagin*, *resinous oil* (to which the slight acridity of the root is probably due), colouring matter, phosphates and malates of lime, and magnesia, and a peculiar sweet principle *glycyrrhizin* $C_{24}H_{36}O_9$ or liquorice sugar.

Glycyrrhizin is precipitated from a strong decoction by the addition of an acid, solution of acid tartrate of potash, or one of the acetates of lead. It is an amorphous yellow powder, with an acid reaction, and a strong bitter-sweet taste. It dissolves in hot water, and the solution gelatinises on cooling. It is insusceptible of fermentation, and does not reduce an alkaline solution of tartrate of copper when boiled with it. It is soluble in alkalies, and the solutions have a brown colour. When boiled with hydrochloric acid it is converted into *glycyrretin*, a bitter resinous substance, and glucose. The *dried* root contains a little glucose.

Action and Uses.—A slight stimulant and demulcent in catarrah. It is usually given in the form of decoction with linseed.

Pharmaceutical Uses.—Powder of the dry root is used for rolling and preserving pills, and for giving consistence to oleo-resins and other soft substance in the formation of pills. It is a constituent of Confectio terebinthinæ, Decoctum sarsæ compositum, Infusum lini, Pilula hydrargyri, P. ferri iodidi, Pulvis glycyrrhizæ compositus, and the two articles following:—

2. **Extractum Glycyrrhizæ liquidum**, *P.B.* *Fluid Extract of Liquorice.*

Preparation.—Macerate 1 pound of *liquorice root* in coarse powder with 2 pints of *water* for twelve hours, strain and press; again macerate the marc with 2 pints more of water for six hours, strain and press. Mix the strained liquors, heat to 212°, strain through flannel; then evaporate by a water bath until it has acquired, when cold, a sp. gr. of 1·16; add to this ⅛ its volume of *rectified spirit;* let the mixture stand for twelve hours, and filter.

Cold water is used to avoid solution of the oleo-resin.

Dose.—1 fluid drachm.

3. **Extractum Glycyrrhizæ**, *P.B. Extract of Liquorice.*

Prepared as the above, but the evaporation is continued, without the addition of spirit, until the extract is of suitable consistence for forming pills.

This extract is dark brown, very sweet, and not at all acrid. It is quite different from **Commercial Extract of Liquorice** or "**Liquorice**," which is prepared in large quantities in the south of Spain, in Italy, and in Sicily, and brought to a proper consistence by evaporating the decoction in copper vessels. It is then formed into roundish or flattened sticks, of a brownish-black colour, often covered with bay leaves. The finest is that marked *Solazzi.* What is called *Refined* liquorice, in black, shining, pipe-like cylinders, is a mixture of liquorice and gum or gelatin. It is apt also to be mixed with flour, starch, coarse sugar, and other adulterations. This form is too well known to require detailed notice.

Pharmaceutical Uses.—A constituent of Confectio sennæ, Decoctum aloes compositum, Mistura sennæ composita, Tinctura aloes, and Trochisci opii.

4. **Pulvis Glycyrrhizæ compositus** (See Preparations of Senna).

ACACIA, SPECIES VARIÆ. Trees yielding Gum Acacia.

Gum Arabic was well known to the early Egyptians and much used in their paintings. Their term for it (*kami*) is the root of the Greek *κο̂μμι* and Latin *gummi.*

Generic Characters.—Shrubs or trees unarmed, or provided with stipular thorns and scattered prickles. *Flowers* polygamous, yellow, white, and occasionally red, in elongated spikes of crowded capitula. *Petals* free, or united into a 4–5 cleft corolla. *Stamens* 8 to 200, distinct or in bundles. *Legumes* dry, bivalved.

A. VERA.—A small tree about 20 feet high, with grey bark. *Leaves* bipinnate. *Flowers* pale yellow, in dense spikes. *Legumes* broad, 3 or 4 inches long. *Hab.*—Forms dense forests in the sandy regions watered by the Senegal, and in Nubia and Kordofan.

According to Schweinfurth (*Aufzähl. u. Beschreib. der Acacien-Arten des Nilgebiets*), this species exclusively yields the pure white gum of Kordofan and the Upper Nile, and also the non-friable, tough, yellowish, red tears of Senegal gum.

A. ARABICA.—(*A. vera*, Willd., *A. Nilotica*, Delile). A moderate-sized tree, the branches with a reddish-brown bark. *Stipules* forming spines ¼ to ½ inch long. *Leaves* bipinnate. *Flowers* axillary, stalked, in 2 to 5 yellow capitula. *Legume* moniliform, short, straight, with few seeds. *Hab.*—Valley of the Nile, throughout Egypt and Nubia, forming large portions of the primæval forests in Southern Nubia on the banks of the White and Blue Nile. Throughout the dry and hot regions of India. Schweinfurth states that it furnishes very little gum, and that none is exported. It produces abundance of gum in India, and probably furnishes a considerable portion of the gum-arabaic exported from Bombay, most of which, however, is previously imported there from the Red Sea ports.

An astringent extract, known to the ancients by the name of *ακακια*, was prepared from the legumes of this and probably of other species. Dr Royle obtained it in the bazaars of India by the old name of *akakia*.

A. STENOCARPA, Hochst.—A large tree called in Abyssinia *Talch, Talha*, or *Kakul*, furnishes the Suakin gum which is collected between the Blue Nile and Upper Atbara. It is a mixture of white and brownish gum, and is remarkable for its brittleness. It is exported from Alexandria.

A. SEYAL, Delile (*A. fistula*, Schweinf.)—A fine tree called *Soffar*. It is known by its pale yellow bark and long white stems. *Hab.*—Southern Nubia and Sennaar. It furnishes an inferior kind of gum.

A. HORRIDA, Willd. (*A. capensis*, Burch).—A large tree called by the Cape colonists *Wittledoorn* or *Karródoorn* and *Doornboom*, yields the gum-arabic of South Africa, where the tree is common.

A. PYCNANTHA, Benth. (*A. decurrens*, Willd.) called *Black* or *Green Wattletree* by the colonists.—*A. dealbata*, Link, the Silver Wattle, and *A. homalophylla*, Cunningh., are the sources of Australian gum-arabic.

Gum exudes spontaneously from fissures in the bark, and concretes in tears and globular masses. In some regions the flow is promoted by making incisions in the bark.

1. **Acaciæ Gummi,** *P.B.* *Gum Acacia.*

A gummy exudation from the stems of one or more species of acacia.

Characters and Tests.—In spheroidal tears, usually from ½ to 1 inch long, nearly colourless, and opaque, from numerous minute cracks, or in fragments with shining surfaces; brittle, of bland mucilaginous taste; insoluble in alcohol, but soluble in water. Dried at 212° it forms with 2 parts of water a mucilage of sp. gr. 1·149; 100 parts of dilute spirit, containing 22 per cent. by volume of alcohol, dissolves 57 parts of gum; when the proportion of alcohol is increased to 40 per cent. 10 parts; and when increased to 50 per cent. only 4 parts. (*Pharmacographia*, p. 211). The aqueous solution gives no precipitate with neutral acetate of lead, but forms with the subacetate an opaque white jelly $3C_6H_{10}O_5,2Pb$. Solution of oxalate of ammonia gives a white precipitate (of calcic oxalate, showing the presence of lime). Aqueous solution of iodine added to the powder, or to a solution formed of boiling water and cooled, fails to produce a blue colour (absence of starch).

At 212° gum loses 12 to 16 per cent. of water = to about 3 molecules; and at 300° it parts with another molecule, and becomes insoluble. If a solution of gum (1 part in 5 of water) be acidulated with 4 or 5 per cent. of hydrochloric acid, and placed in a dialyser till the solution no longer precipitates argentic nitrate, it will exhibit characters different from a solution of ordinary gum; thus it has an acid reaction, and is no longer precipitated by alcohol or oxalate of ammonia; and when dried at a gentle heat, is no longer soluble, and merely swells when boiled with water. In fact, it has been decomposed, the bases (potassium and calcium) have been removed, and the feeble vegetable acid, *arabic acid* or *arabin* $C_{12}H_{22}O_{11}$, the substance under consideration, remains. Arabic acid unites with bases with the simultaneous liberation of a molecule of water. A small quantity of alkali renders it soluble in water, and the solution resembles one of ordinary gum. Gum acacia may therefore be regarded as a salt formed of a feeble vegetable acid—arabic—with either calcium or potassium, or both. It is probably a double salt, and may be represented by the following formula, $[CaK(C_{12}H_{20}O_{10})_2,6C_{12}H_{22}O_{11}]$. Gum acacia yields from 3 to 4 per cent. of ash, composed of carbonates of lime, magnesia, and potash.

Gum is insusceptible of alcoholic fermentation, but when digested with cheese and chalk will yield 12 per cent. of alcohol. Boiled with sulphuric acid it is converted through dextrine into sugar. Concentrated nitric acid resolves it into mucic and oxalic acids.

Incompatibilities.—Alcohol, æther, chloroform, ammonia, acetate of lead, subacetate of lead, mercurous and mercuric nitrates, silicate of potash, and the neutral oxalates, all produce deposits in a solution of gum acacia. Borax and prechloride of iron render it gelatinous.

Action and Uses.—Gum is topically emollient and demulcent, and when the natural secretion is deficient it may serve as an effectual protection to an inflamed mucous membrane. The demulcent action is practically assumed by some to be general, extending to the urinary tract, and there calming irritation, but of this there is no evidence. From the parallel case of albumen we may indeed infer that the stomach is able to convert gum into a compound which may readily pass through the animal membranes into the blood, but analogy also leads to the inference, that if it be not previously converted into sugar, it would become so converted in the blood, and be disposed of accordingly. In dryness of the mucous membrane, of the fauces, as in catarrh, and after continued exertion of the voice, gum gives great relief. It is most usefully employed to suspend insoluble medicines, such as the oxyde or nitrate of bismuth, and in the formation of lozenges. It may be taken *ad libitum*.

Pharmaceutical Uses.—In the preparation of all the lozenges, Pulvis amygdalæ compositus, Pulvis tragacanthæ compositus, Mistura cretæ, Mistura guaiaci, and the following article:—

2. **Mucilago Acaciæ**, *P.B.* *Mucilage of Gum Acacia.*

Preparation.—Put 4 ounces of *gum acacia* in small pieces and 6 ounces of *water* into a covered earthern jar, and stir them frequently until the gum is dissolved. If necessary, strain through muslin.

Pharmaceutical Uses.—An adjunct to linctuses and various mixtures containing oleo-resin or insoluble powders, and used in the preparation of all the lozenges.

ACACIA CATECHU, *Willd.* The Catechu Acacia.

This is a small tree, with straggling thorny branches, and hard, heavy, dark-red wood. It is common throughout India, Burmah, the hotter regions of Ceylon, and the tropical parts of Eastern Africa.

Characters.—Stipules thorny. *Leaves* bipinnate; *leaflets* auricled at the base. *Petiole* angular, often armed with a row of prickles on the under surface. *Flowers* white. *Calyx* downy, 5-fid. *Corolla* monopetalous, 5-fid.—*Roxb. Corom. Plants,* ii. t. 175.

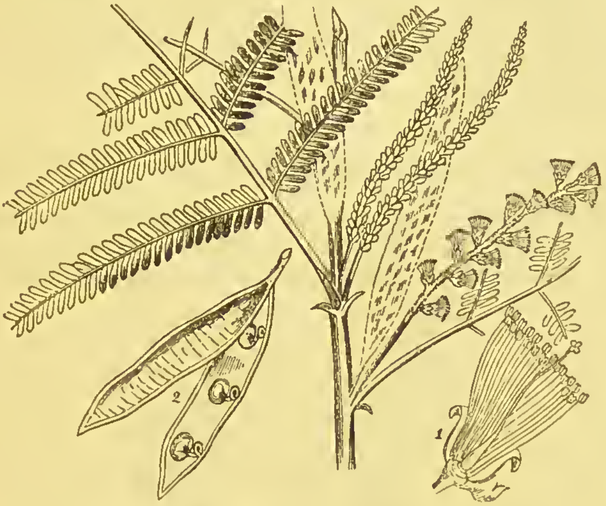

Fig. 107.—*Acacia Catechu.* 1. Separate Flower.

According to Brandis (*Forest Fl. N.-W. and Cent. India,* 187), *Acacia suma,* a larger tree growing in Mysore, Bengal, and Gugerat, is also a source of catechu.

Catechu nigrum. *Black* or *Pegu Catechu: Cutch* or *Kut. Terra Japonica.*

This is an aqueous extract of the heart-wood. It is imported from Pegu.

Extraction.—When the tree is about a foot in diameter it is felled, and the wood is cut into chips, which are placed with water in a series of earthen jars over a wood fire. Ebullition is allowed to proceed until the liquor becomes dark and strong. It is then decanted, and evaporated to a semi-solid consistence, when it is poured into rude moulds of clay or leaves, and allowed to harden in the sun.

Characters and Composition.—Blackish-brown, in irregular masses, often weighing many pounds, made up of oblong pieces about 8 inches by 3, enveloped in leaves. The fracture is shining, and the taste bitterish and very astringent.

In the north of India a pale Acacia catechu is made. Dr Royle met with it in the bazaars at Calcutta. It occurs in irregular portions of a cake about an inch thick. It has a sweetish, very astringent taste.

Catechu is composed of about equal parts of *catechu-tannic acid* and *catechin.* The former is soluble in cold water, the solution being of a dark-brown colour and possessing the characters of a solution of tannic acid. The insoluble portion is a mass of acicular crystals, *catechin* or *catechuic acid,* $C_{13}H_{12}O_5$. It is soluble in æther. Æther extracts from a cold aqueous solution of catechu a trace of *quercetin,* $C_{27}H_{18}O_{12}$, a yellow crystalline body (see p. 619). When catechu is subjected to dry distillation, it yields pyrocatechin, $C_6H_6O_2$. In these and all other characters it agrees with the pale catechu of the Pharmacopœia, furnished by *Uncaria Gambier* (see p. 552).

Action and Uses.—Those of the cinchonaceous catechu (see p. 552), which is alone officinal.

Dose.—10 to 30 grains.

HÆMATOXYLON CAMPECHIANUM, *Linn.* The Logwood Tree.

Logwood is noticed by Monardes for its medical uses; but it has also been long employed in dyeing. It is a native of the coast of Campeachy, but is now common in the West Indies and in India.

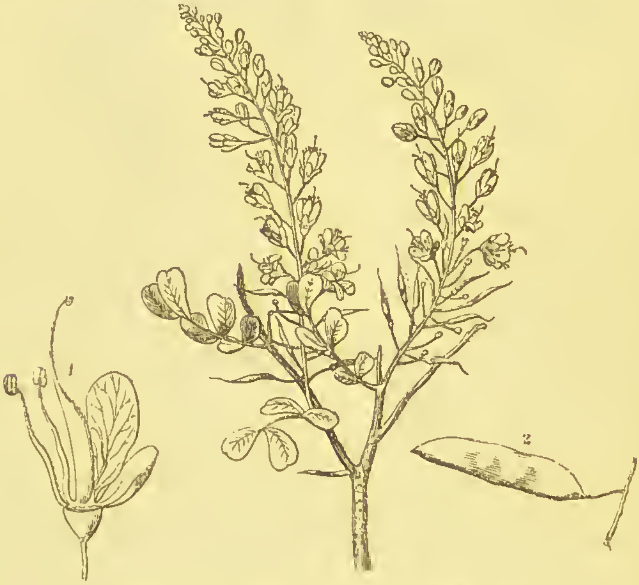

Fig. 108.—*Hæmatoxylon Campeachianum.*
1, Constituent parts of the flower; 2, The pod.

Characters.—A *tree* (fig. 108) of moderate size, stem generally crooked, spiny in arid, but unarmed in moist situations. *Leaves* 2–4 from the same point, pinnate; *leaflets* 2 to 4 pairs, obovate or obcordate. *Flowers* racemose, yellow. *Sepals* 5, united at the base into a permanent cup, limb purplish and deciduous. *Petals* 5, obovate, a little larger than the sepals. *Stamens* 10, hairy at the base. *Legume* small, compressed, lanceolate, pointed at each end, 2-seeded, sutures indehiscent, valves bursting longitudinally in the middle.—*Sloane's Hist.* 2, t. x. f. 1 to 4; *Woodv. Med. Bot.* pl. 17.

The sap-wood of this tree, being light-coloured, is rejected, but the interior red-coloured wood is imported in logs, chiefly for the use of the dyer. It is hard and tough, sp. gr. 1·057.

1. **Hæmatoxyli lignum**, *P.B.* *Logwood.*

The sliced heart-wood of the tree above described, imported from Campeachy, Honduras, and Jamaica.

Characters and Constituents.—The logs are externally of a dark colour, internally they are reddish-brown; the chips have a feeble agreeable odour, and a sweetish taste; a small portion chewed imparts to the saliva a dark pink colour. The colouring matter is deposited in the walls of the prosenchyma and vessels, and may sometimes be seen in the form of greenish isolated crystals. The parenchyma is loaded with large crystals of calcic oxalate. The chips commonly present a beautiful green or greenish-yellow lustre, due to the formation of crystalline hæmateïn.

The essential constituent is *hæmatoxylin*, $C_{16}H_{14}O_6$, which exists in the proportion of 9 to 12 per cent. When pure, it exists as colourless crystals with from 1 to 3 molecules of water; on exposure to light the crystals become red. They are freely soluble in hot water and in alcohol, and sparingly in cold water and in æther. With alkalies hæmatoxylin forms a dark violet solution, which soon becomes yellowish-brown. It is decomposed into hæmateïn, $C_{16}H_{12}O_6$, a crystalline body of a brilliant green hue, by the combined action of oxygen and ammonia, and this body again reverts to hæmatoxylin under the influence of hydrogen or sulphurous acid. When fused with potash, hæmoxylin is converted into pyrogallic acid, $C_6H_6O_3$ (Erdmann and O. Hesse).

Adulteration.—Brazil wood (derived from species of Cæsalpinia) is sometimes mixed with logwood chips. Its crystalline colouring matter, brasilin, $C_{22}H_{20}O_7$, forms a *red* solution with the alkalies, by which its presence may be known.

Action and Uses.—A mild *astringent* and *tonic.* It is very suitable in the diarrhœa of phthisis. It may be given in one of the following forms:—

2. Decoctum Hæmatoxyli, *P.B.* *Decoction of Logwood.*

Preparation.—Boil 1 ounce of *logwood chips* in 1 pint of *water* for ten minutes, add towards the end 60 grains of *cinnamon bark* in coarse powder; then strain, and wash the chips with sufficient water to make 1 pint of the decoction.

Acids render the decoction a brighter red, and throw down a slight precipitate. Alkalies produce a purple colour, as above stated. Alum, acetate of lead, and the salts of iron cause precipitates; that caused by the latter is bluish-black. The addition of gelatin causes the separation of reddish flakes.

Dose.—1 to 3 fluid ounces.

3. Extractum Hæmatoxyli, *P.B.* *Extract of Logwood.*

Preparation.—Infuse I pound of *logwood* in fine chips in 1 gallon of *boiling water* for twenty-four hours. Then boil down to one-half; strain, and evaporate to dryness by a water bath, stirring with a wooden spatula. Iron vessels must not be used.

Characters and Composition.—A blackish, brittle mass, easily crushed, and then forming angular fragments with shining surfaces, and a dark-red powder, like kino. It is composed of a mixture of hæmatoxylin and hæmateïn.

Dose.—10 to 30 grains.

PTEROCARPUS MARSUPIUM, *Roxb.* The Indian Kino.

A lofty tree, 40–80 feet high, native of Ceylon and the adjacent part of India.

Characters.—Bark reddish-brown externally, and red internally. *Leaves* unequally pinnate; *leaflets* 5–7, alternate, elliptical, slightly emarginate, coriaceous, dark-green, and shining, 3 to 5 inches long. *Panicles* terminal. *Flowers* papilionaceous, white, with a tinge of yellow. *Stamens* 10, monodelphous below, in two sets above. *Ovary* 1 or 2-celled. *Legume* woody, indehiscent, winged, upper edge straight, the lower curved excepting towards the base, generally 2-celled. *Seed* solitary, reniform.—*Roxb. Corom.* pl. 116; *Flor. Ind.* iii. p. 234.

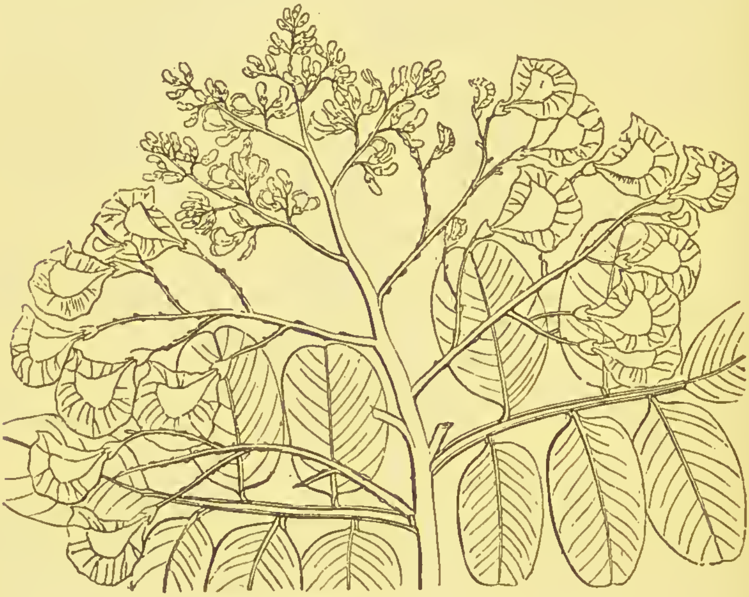

Fig. 109.—*Pterocarpus marsupium.*

The wood is replete with a red, watery juice, which, as it exudes, has the appearance of red currant jelly, but concretes into a brittle solid after a few hours' exposure. It is obtained by making a perpendicular incision in the trunk, collecting the juice in suitable vessels, and allowing it to dry by exposure to the sun.

1. Kino, *P.B.* *Kino.*

The inspissated juice obtained from incisions made in the trunk of the tree above described. Imported from Malabar.

Characters and Composition.—In small, angular, brittle, glistening reddish-black fragments, translucent, and ruby-red on the edges, inodorous, very astringent. When chewed it tinges the saliva blood-red. Cold water dissolves it partially, forming a red solution: boiling water more copiously, and depositing a red sediment in cooling. The solution assumes an intense and splendid violet colour when agitated with a little reduced iron, or a neutral solution of ferrous sulphate. The aqueous solution is decolorised by acids, and the colour is restored by alkalies. Alcohol dissolves the greater portion.

Kino may be best defined as an aqueous extract. It resembles Pegu catechu in composition. It yields to æther a minute proportion of *pyrocatechin*, which separates in scaly crystals. Dilute mineral acids produce a light red precipitate of *kino tannic acid*, and this yields, by prolonged boiling, a deposit of *kino-red.* When submitted to dry distillation kino furnishes *pyrocatechin;* and when fused with caustic potash *pyrocatechuic acid* and *phloroglucin.*

Incompatibilities.—Gelatin, which forms a greenish precipitate; mineral acids, salts of iron, silver, lead, mercury, and antimony; alkalies, which increase its solubility, but destroy its astringency.

Varieties of Kino.—Other leguminous plants, and the myrtaceous genus Eucalyptus, also yield kino. 1. **African,** or **Gambia Kino.** This is the produce of *Pterocarpus erinaceus*, Poiret, *The Kano Tree*, a native of Senegambia and Angola. It agrees with Malabar kino in characters and composition. The Portuguese of Angola use it under the name *Sangue de Drago* (Welwitsch). 2. **Butea, Bengal,** or **Palas Kino** is the produce of *Butea frondosa*, Roxb., *The Dhak Tree* (*Fl. Ind.* iii. p. 245, and *Proc. Asiat. Soc.* May 1838), a highly ornamental tree, with magnificent orange-coloured papilionaceous flowers. The ruby-coloured juice flows from natural cracks or incisions during the hot season. The extract is in tears or stalactical pieces of a ruby-red colour and transparent. It is almost wholly soluble in water, and has a pure astringent taste. According to E. Solly, it is composed of 73·26 per cent. of tannic acid, probably the modification known as *kino-tannic*, 5·05 of difficultly soluble *extractive*, and 21·67 of some modification of *gum*, with a little gallic acid. It is used in India instead of Malabar kino. It is known as *Kīni e gond* and *Kumrkus.* It has been occasionally sent to this country. 3. **Eucalyptus, Australian,** or **Botany Bay Kino.** The produce of some 16 species of Eucalyptus. It may be obtained by incisions, but is found as a natural collection in flattened cavities in the solid trunk. It has been imported in a semi-fluid condition. It agrees with Malabar catechu in characters and composition, being usually soluble in water or spirit, and giving with dilute mineral acid a precipitate of kino-tannic acid. Some kinds contain so much gum that the drug is nearly insoluble in alcohol.

Action and Uses.—Those of catechu, than which it is, on account of its comparative insolubility, less astringent.

Dose.—10 to 30 grains.

Pharmaceutical Uses.—In the preparation of the two articles next following, and of the Pulvis catechu compositus.

2. **Tinctura Kino,** *P.B.* *Tincture of Kino.*

Preparation.—Macerate 2 ounces of *kino* in *coarse powder* in 1 pint of *rectified spirit* for seven days, with occasional agitation; filter, and add sufficient *rectified spirit* to make 1 pint.

Dose.—½ to 1 fluid drachm.

3. **Pulvis Kino compositus**, *P.B.* *Compound Kino Powder.*

20 grains contain 1 grain of powdered opium.

Preparation.—Mix thoroughly 3¾ ounces of *kino*, ¼ ounce of *opium*, and 1 ounce of *cinnamon bark*, all in powder; pass the powder through a fine sieve, and lastly rub it lightly in a mortar. Keep it in a stoppered bottle.

Action and Uses.—Astringent and anodyne in gastralgia with pyrosis, and in diarrhœa.

Dose.—5 to 20 grains.

PTEROCARPUS SANTALINUS, *Linn. fil.* The Red Sandal Tree.

This small tree was pointed out by Kœnig as yielding red sandal-wood. Its wood is dark-red with dark-coloured veins, heavy and compact, capable of taking a fine polish; when moistened with water, it said to produce a fine red colour; and a reddish juice exudes from its bark, which Kœnig considered a kind of dragon's blood. It is native of Ceylon and the southern parts of India, abounding to the west and north-west of Madras, in the forests of the southern parts of the Kurnool Hills, Cuddapah, and North Arcot.

Characters.—Closely resembles *P. marsupium*, from which it is distinguished by the broader *leaflets*, which are usually 3, rarely 4 or 5, alternate, roundish, retuse, smooth above. *Racemes* axillary, simple, or branched. *Petals* long-clawed, crenate, undulate. *Standard* yellow, streaked with red. *Filaments* 10, diadelphous or triadelphous (5, 4, and 1). *Legume* suborbicular, stalked, 1-seeded; the wing somewhat membranous, waved.—*Woodv. Med. Bot.* pl. 254, and *Beddome, Flor. Sylvat. of South. India*, tab. xxii.

1. **Pterocarpi lignum**, *P.B.* *Red Sandal-wood.*

The wood of the plant above described, from Ceylon. It is called in India *Rukta Chundun*, which signifies red sandal, but the natives apply this term to the wood of *Adenanthera Pavonina*, an old dye-wood also.

Characters and Constituents.—Dense, heavy billets, outwardly dark-brown, internally variegated with dark and lighter-red rings if cut transversely. Powder blood-red, of a faint, peculiar odour, and an obscurely astringent taste. Also chips of the same. The colouring matter is contained in the prosenchyma and ducts; the parenchyma is laden with crystals of calcic oxalate, which are often large enough to be seen with the naked eye.

The essential constituent is a resinous ruby-coloured crystalline substance called *santalin* or *santalic acid*, $C_{15}H_{14}O_5$, which is insoluble in water or fixed oils; but soluble in alcohol, æther, acetic acid, and partially in oil of cloves, lavender, and rosemary, but not at all in oil of turpentine. It fuses at 202°, neutralises the alkalies, but forms uncrystallisable salts. Weidel obtained, by exhausting the wood with water containing a little potash, and precipitating by hydrochloric acid, a minute quantity of *santal*, $C_8H_6O_3$, which separates from boiling alcohol in colourless, tasteless crystals, forming with potash a straw-coloured solution, which soon becomes red and green. The wood also contains a small quantity of *kino-tannic acid* (see p. 645).

Incompatibilities.—Acids which precipitate santalin, solutions of the metallic salts which throw down red or violet precipitates.

Action.—Feebly astringent.

Pharmaceutical Uses.—It is exclusively employed as a colouring agent, through the medium of Tinctura lavandulæ composita (see Liquor arsenicalis).

TAMARINDUS INDICA, *Linn.* The Tamarind Tree.

The Tamarind is a native of both the East and West Indies, and has been long used as an article of diet and medicine. The Arabs, on becoming acquainted with it, called it *Tamr hindee*—that is, "the Indian date," whence, no doubt, the Latin name is derived.

Characters.—A lofty *tree* with crooked *branches,* remarkable for its light and elegant foliage. *Leaves* abruptly pinnate, with 10 to 15 pairs of *leaflets,* which are small, narrow, oblong, obtuse; *stipules* small, deciduous. *Flowers* in lateral and terminal racemes, of a yellow colour variegated with red. *Calyx* turbinate at the base, limb bilabiate, reflexed, upper lip tripartite, lower broad, 2-toothed. *Petals* 3, unilateral, the middle cucullate. *Stamens* 2–3 united together, and fully developed, 7 very short and sterile. *Ovary* stalked; *style* subulate. *Legume* pendulous, broad and thickish, indehiscent. *Epicarp* brittle, scabrous. *Sarcorarp* pulpy, pervaded by strong fibres. *Seeds* from 3 to 12, covered by a membranous coat, flattened, bluntly 4-angled, smooth, hard, and brown coloured, inserted into the convex side of the legume.—*Woodv. Med. Bot.* pl. 166.

The legumes are from 3 to 6 inches long, and as broad as the finger or thumb; the hard epicarp encloses three bundles of ramifying fibres, which, starting from the stalk, spread out and form a skeleton of woody fibres, which pervade the firm juicy pulp. In the West Indies the outer shell is removed, and the fruits are then preserved between layers of moist sugar or in syrup. These are the "Brown or Red Tamarinds," and are further distinguished from East Indian or "Black Tamarinds" by their sweetness and juiciness, the latter being imported in a dry condition, and with portions of the husk.

Tamarindus, *P.B.* *Tamarind.*

The preserved pulp of the fruit, imported from the West Indies.

Characters, Constituents, and Test.—A brown, sweetish, acidulous pulp, preserved in sugar, containing strong fibres and brown shining seeds. According to Vauquelin, the pulp is composed as follows, in 100 parts:—Large-celled parenchyma 34·35 parts, water 27·55, citric acid 9·4, tartaric acid 1·55, malic acid 0·45, acid tartrate of potash 3·25, gum 4·7, pectin 6·25, sugar 12·5. (As this analysis refers to the unpreserved fruit, at least twice as much sugar will be found in West India tamarinds.) A portion of the citric acid is probably combined with potash; another portion undergoes, after a time, decomposition into acetic and carbonic acids (see Citric acid).

The seeds are enclosed in a membranous endocarp. They contain a large quantity of tannin.

A piece of bright iron left in contact with the pulp for an hour does not exhibit any deposit of copper. Copper has been occasionally detected in tamarinds, derived no doubt from copper vessels with which they have been in contact.

Action and Uses—Refrigerant, laxative. A syrup of tamarind diluted with water, or infusion sweetened, is a grateful drink in the feverish state. Tamarind whey, made by boiling 2 ounces of the pulp in a quart of milk, may be similarly used. The pulp is also a good vehicle for powders, such as Pulvis jalapæ compositus and Pulvis scammonii compositus.

Pharmaceutical Uses.—It is a constituent of Confectio sennæ.

CASSIA FISTULA, *Linn.* Purging Cassia.

A handsome tree, from 20 to 50 feet high, with leaves resembling the ash, and showy racemes of bright yellow, fragrant flowers from 1 to 2 feet long, followed by cylindrical pods of the same length.

Characters.—*Leaflets* 4 to 8 pairs, smooth, acute, from 2 to 4 inches long. *Flowers* on long pedicels. *Sepals* 5, unequal. *Petals* 5, unequal. *Stamens* 10, free, 3 lower ones longer, the 4 middle ones short and straight, the 3 upper with abortive anthers. *Anthers* dehiscing at the apex. *Ovary* smooth, 1-celled, with numerous seeds. *Legume* woody, smooth, cylindrical, indehiscent, with 3 longitudinal sutures, one of which is opposite to two collateral ones, internally divided into a great number of 1-seeded cells by thin transverse partitions. *Seeds* 25 to 100, flattish, oval, about ⅓ of an inch long, imbedded in a soft dark-brown saccharine pulp.—*Woodv. Med. Bot.* pl. 163.

1. Cassiæ Pulpa, *P.B.* *Cassia Pulp.*

The pulp obtained from the pods of the plant above described, imported from the East Indies, or recently extracted from pods imported from the East or West Indies.

Characters and Composition.—Blackish-brown, viscid, sweet, a faint senna odour. It usually contains the seeds and dissepiments.

It is composed of *sugar*, *pectin*, *gum*, and a *cathartic principle* probably identical with that of senna leaves.

Action.—A mild laxative in doses of 1 drachm to 1 ounce, given with manna and tamarind, or in the following combination:—

2. Confectio Sennæ, *P.B.* *Confection of Senna, Lenitive Electuary.*

Preparation.—Boil 12 ounces of *figs* and 6 ounces of *prunes* gently with 24 ounces of *water* in a covered vessel for four hours, then having added water to make up the original weight, mix 9 ounces each of *tamarind* and *cassia pulp* with it; digest for two hours, and rub the pulp through a hair sieve. To the *separated* pulp then add 30 ounces of *refined sugar* and ¾ ounce of *extract of liquorice*, and dissolve them with a gentle heat; while the mixture is still warm add to it gradually 7 ounces of *senna* and 3 ounces of *coriander fruit*, each previously reduced to fine powder and mixed together. Mix the whole thoroughly, making the weight of the compound 75 ounces by evaporation or the addition of more water.

Action and Uses.—A pleasant and efficient laxative for children, and adults who, from dilated condition of the veins of the rectum, cannot bear aloetic or other strong purgatives.

Dose.—60 to 120 grains.

CASSIA ACUTIFOLIA, *Delile.* Acute-leaved Senna.

Synonyms.—C. lanceolata, Lamarck, *Encyc.*, and Nees, *Plant. Med.* plate 345; *C. senna β*, Linn.; *C. lenitiva*, Bisch.

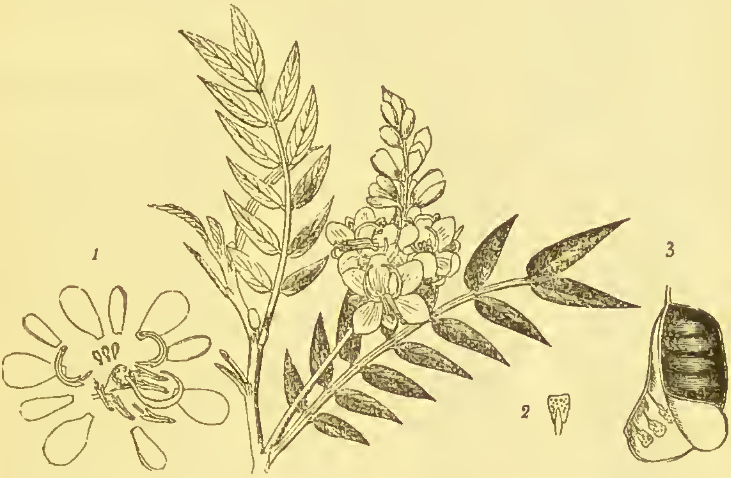

Fig. 110.—*Cassia acutifolia.* I, parts of flower; 3, legume; 2, seed.

Characters.—A leafy shrub 2–5 feet high, with angular branches. *Leaflets* ovate-acute, slightly mucronate. *Stipules* subulate. *Racemes* axillary, erect. *Flowers* yellow. *Ovary* falcate, with a smooth recurved style. *Legume* flat, membranous, broadly oblong, very slightly curved inwards, rounded at the extremity, the ventral suture terminating in the indurated and nearly obsolete style.—*Delile, Esenbeck, and Eberm.* t. 346. *Habitat.*—Nubia, Kordofan, Sennaar, Timbuktu.

Senna Alexandrina, *P.B.* *Alexandria Senna.*

The leaflets of the plant above described.* Imported from Alexandria, carefully freed from the flowers, pods, and leaf-stalks of the same, and from the leaves, flowers, and fruits of *Solenostemma argel*, Hayne (see p. 520).

Characters and Tests.—Lanceolate or obovate leaflets, about 1 inch long, unequally oblique at the base, brittle, greyish-green, of a faint peculiar odour, and mucilaginous sweetish taste. The unequally oblique base and freedom from bitterness distinguish the senna from the argel leaves (fig. 111, D), which are thicker, stiffer, and finely rugose, somewhat like the sage-leaf, equal sided, and with very obscure veins.

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* *Cassia obovata,* Colladon (Nees, *Plant. Med.* plate 347 and 348), is mentioned in the Pharmacopœia as a source of Alexandrian senna, but it is almost exclusively composed of the *acutifolia.* The leaflets of the former have a broad extremity with a short central point, and the legume is reniform, with a sharp undulating ridge along the middle of each valve.

CASSIA ELONGATA, *Lemaire.* Long-leaved Senna.

Synonyms.—C. angustifolia, Vahl and Batka; *C. lanceolata*, Roxb., Royle, *Him. Bot.* t. 37; *Senna officinalis*, Roxb.

Characters.—Leaflets ovate-lanceolate, from 1 to nearly 2 inches long. *Flowers* bright yellow. *Legume* oblong, membranous, about $1\frac{1}{2}$ inch long and $\frac{5}{8}$ broad, ventral broader, nearly straight, and ending in the enlarged indurated style, narrowed and rounded at the base.—*Royle, Bot. Himal.* plate 37. *Habitat.*—Southern Arabia, Soumali coast of Africa, Scind, and Punjab.

1. Senna Indica, *P.B.* *Tinnevelly Senna.*

The leaflets of the plant above described, from plants cultivated in Southern India.

Characters and Constituents.—About 2 inches long, lanceolate, acute, unequally oblique at the base, flexible, entire, green, without any admixture; odour and taste those of Alexandria senna.

Constituents.—The purgative properties of senna are due to *cathartic acid*, $C_{180}H_{192}O_{82}N_4S$ (Dragendorff and Kubly, *Gmelin's Chemistry*, xviii. 240; Grove's *Pharm. Journ.* 1869, vol. x. 196). It is a black colloid body, containing both sulphur and nitrogen. It decomposes the carbonates of the alkali metals, and forms a dark solution from which it is precipitated unaltered by many acids. It is not affected by tannic acid. It has a slight acid and astringent taste; is soluble in æther and chloroform, but is almost insoluble in water and in alcohol, but dissolves in warm dilute alcohol. This is in strict conformity with experience, a weak alcoholic infusion having long been known to be considerably stronger than an aqueous one. Messrs T. and H. Smith (*Pharm. Journ.* x. 315) state that the active principle is decomposed and rendered inert by alkalies at a boiling heat. In order to prepare a tasteless and efficient infusion, they recommend that the leaves be exhausted by alcohol, which removes nauseous extractive, and then infused in cold water (*Jour. de Chimie et de Pharmacie*, 1874). When boiled with alcohol and hydrochloric acid, cathartic acid is resolved into sugar and *cathartogenic acid.* Besides this essential constituent, senna contains a yellow colouring matter identical with *chrysophanic acid;* according to some chemists a peculiar crystalline sugar, *catharto-mannite*, which is insusceptible of fermentation, and does not precipitate suboxyde of copper; and a considerable quantity of tartrate and oxalate of potash and lime.

"*East Indian*," "*Bombay*," or more correctly "*Arabian senna*," is one of the kinds found in the London market; it is derived without much care from the wild plant of this species growing in Southern Arabia, and is exported from Aden and other ports on the Red Sea to Bombay. The cultivated plants which furnish the more luxuriant Tinnevelly senna were originally derived from Arabia.

Incompatibilities.—Alcohol and mineral acids, in which the cathartic acid is insoluble.

Impurities.—Alexandrian senna often contains a large admixture of argel leaves (fig. 111, D). Little dense corymbs of the asclepiadaceous flowers of this plant, may often be detected, and very rarely the slender pyriform follicles containing the comose seeds characteristic of the order. The leaves of another Egyptian plant, *Tephrosia Apollinea* (fig. 111, F); those of *Coriaria myrtifolia* (fig. 111, E), a Mediterranean shrub; and those of *Colutea arborescens*, have been found in senna, but not of late years, and their presence was probably accidental, and therefore exceptional. The leaves of Coriaria are said to be poisonous; those of argel are, according to Christison, purgative, and are liable to produce griping. Tinnevelly senna, which never contains these leaves, should therefore be preferred to Alexandrian.

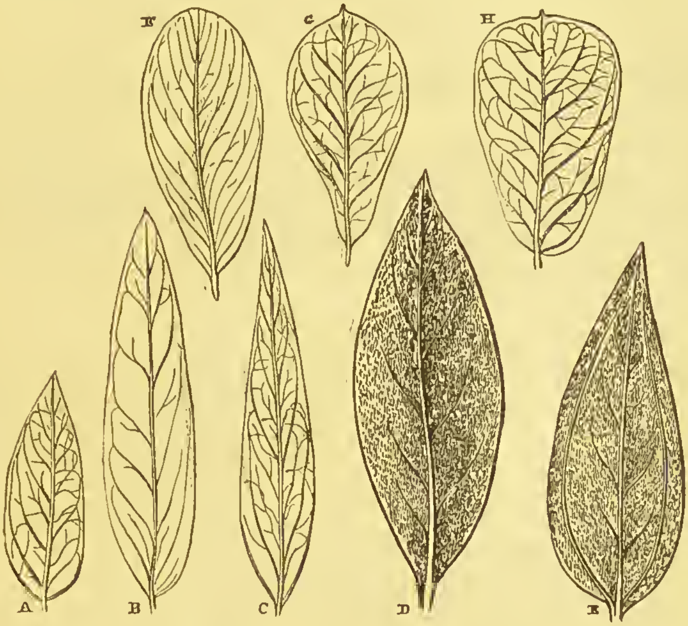


Fig. 111.—A and C, Cassia acutifolia; B, C. elongata; D, Sólenostemma Argel; E, Coriaria myrtifolia; F, Tephrosia Apollinea; G and H, C. obvata.

Action and Uses.—Senna is a brisk and safe cathartic. It is only slightly irritant in its action, and may therefore be given with safety in almost any case. The cathartic acid is absorbed and passes out of the secretions unaltered, as appears from the cathartic effect of the milk of the nurse who has taken senna on the infant. It is eliminated chiefly by the mucous membrane of the intestines, for the intravenous injection of the infusion is followed by purging as if the medicine had been taken by the stomach. When suitably combined it rarely gripes.

Dose.—30 to 120 grains, in the form of powder or infusion.

Pharmaceutical Uses.—An ingredient of Confectio sennæ and of the five articles next following:—

2. **Infusum Sennæ,** *P.B.* *Infusion of Senna.*

Pour 10 fluid ounces of boiling *water* on 1 ounce of *senna* and 30 grains of *sliced ginger*, infuse in a covered vessel for an hour, and strain.

In this and the following preparation the Pharmacopœia is in error in prescribing a boiling heat; the temperature should not exceed 120°.

Dose.—1 to 2 fluid ounces, usually in combination, as in the following:—

3. **Mistura Sennæ composita,** *P.B.* *Compound Mixture of Senna. Black Draught.*

Preparation.—Dissolve 4 ounces of *sulphate of magnesia* and ½ ounce of *extract of liquorice* in 14 fluid ounces of *infusion of senna*, with the aid of a gentle heat, then add 2½ fluid ounces of *tincture of senna* and 10 fluid drachms of *compound tincture of cardamoms*, and sufficient infusion of senna to make 1 pint.

Dose.—1 to 1½ fluid ounce.

4. **Tinctura Sennæ,** *P.B.* *Tincture of Senna.*

Macerate 2½ ounces of *senna broken small*, 2 ounces of *raisins* freed from seeds, and ½ ounce each of bruised *caraway* and *coriander fruits* for forty-eight hours in 15 fluid ounces of *proof spirit*, afterwards percolate and obtain 1 pint of tincture, as directed under Tinctura aconiti.

Dose.—2 to 8 fluid drachms. A good adjunct to the infusion as it is to Mistura sennæ composita.

5. **Syrupus Sennæ,** *P.B.* *Syrup of Senna.*

Preparation.—Digest 16 ounces of *senna* broken small in 70 ounces of *water* for twenty-four hours at 120°; press out the liquor, and strain it. Digest the marc in 30 ounces more water for six hours, also at 120°; press and strain as before. Evaporate the mixed liquors in a water bath to 10 fluid ounces, and when cold add 3 minims of *oil of coriander* dissolved in 2 fluid ounces of *rectified spirit.* Filter and wash the residue with water so as to make the filtrate measure 16 ounces. Then add 24 ounces of *refined sugar*, and dissolve by the aid of a gentle heat. The product should weigh 2 pounds 10 ounces, and have the sp. gr. 1·310.

A more efficient preparation may be made by using alcohol (1 part to 8 of water) in the infusion.

The heat of water is too great, the evaporation may be as rapidly effected in shallow dishes at 120°, when there would be little risk of decomposing the salts of cathartic acid. Properly prepared it is a very pleasant and efficient preparation of senna, and is admirably adapted for young children.

Dose.—1 to 4 fluid drachms; the latter is rather a luscious dose.

6. **Pulvis Glycyrrhizæ compositus,** *P.B.* *Compound Powder of Liquorice.*

A sifted mixture of 2 ounces each of *senna* and *liquorice root*, and 6 ounces of *refined sugar*, all in fine powder.

As senna is the essential ingredient, this preparation would be more appropriately called Pulvis sennæ compositus. The addition of 1 ounce each of powdered fennel fruit and washed sulphur to the above constitutes the *Pulvis liquoritiæ compositus* of the German Pharmacopiœa.

Action and Uses.—A mild aperient, suitable for children.

Dose.—30 to 60 grains.

SAROTHAMNUS SCOPARIUS, *Wimmer.* The Common Broom.

Spartium scoparium, Linn. *Cytisus scoparius*, Link. Σπάρτιον of Dioscorides.

Characters.—A shrub 2-3 feet high, with straight, twiggy, angular, and glabrous branches. *Leaves* minute, ternate. *Flowers* axillary, solitary or in pairs, large, bright-yellow. *Calyx* with the upper lip entire. *Keel* very blunt; *stamens* enclosed within the keel, monadelphous. *Pod* almost black, compressed, hairy along the margins; *seeds* numerous.—*Woodv. Med. Bot.* plate 89.

1. Scoparii cacumina, *P.B.* *Broom Tops.*

The fresh and dried tops of the indigenous plant above described.

Characters and Constituents.—Straight, angular, dark-green, smooth, tough twigs, of a bitter nauseous taste, and of a peculiar odour when bruised.

According to Stenhouse (*Jour. Chem. Soc.* xv.) broom tops contain scoparin and spartein. *Scoparin*, $C_{21}H_{22}O_{10}$, is a neutral or slightly acid body, separating from alcohol partly as crystals and partly as jelly; it is free from taste and smell, and when fused with potash is resolved into phloroglucin, $C_6H_6O_3$, and protocatechuic acid, $C_{14}H_{12}O_8$.

Spartein, $C_{15}H_{26}N_2$, is an alkaloid, forming extremely bitter crystallisable salts with bases. Like conia and nicotina, it is fluid and destitute of oxygen. It exists as a colourless oily liquid, heavier than water, and but sparingly soluble in it. Broom grown in the shade contains less than that which flourishes on sunny banks. It is extracted from the plant by means of an acidulated aqueous infusion. This is then concentrated and distilled with soda. The distillate is saturated with hydrochloric acid, evaporated to dryness, and distilled with potash. The oily spartein is then dried and rectified.

Action and Uses.—We have no observations on the action of spartein on man. The following, according to Fick, are its effects on the lower animals. It has no marked action on the cerebrum, but like conia paralyses the motor nerves, and toxic effects follow from depression of the reflex function of the spinal cord, ending in paralysis of the respiratory centres.

The action of the plant itself is decidedly irritant, large doses of the decoction producing nausea or actual vomiting and purging. Small doses are laxative and diuretic, and these properties being constant and uniform, render the plant one of the most reliable remedies in the treatment of dropsies which are not directly or altogether dependent on recent disease of the kidneys. Its use is generally contra-indicated in acute nephritis.

2. Succus Scoparii, *P.B.* *Broom Juice.*

Prepared from *fresh boom tops* in the manner and proportions directed for Succus conii.

This is a very efficient preparation.

Dose.—1 to 4 fluid drachms.

3. Decoctum Scoparii, *P.B.* *Decoction of Broom.*

Preparation.—Boil 1 ounce of *dried broom tops* for ten minutes in a covered vessel, then strain, washing the contents of the strainer with a little water to make the decoction measure 1 pint.

Dose.—2 to 4 fluid ounces.

PHYSOSTIGMA VENENOSUM, *Balfour.* The Calabar Bean.

This lofty and suffruticose twining plant is allied to the genus Phaseolus. It obtains it name from its peculiar hooded stigma (φυσάω to inflate, and στιγμα). It is a native of Western Africa, where its large bean, called *Eséré,* is used as an ordeal poison.

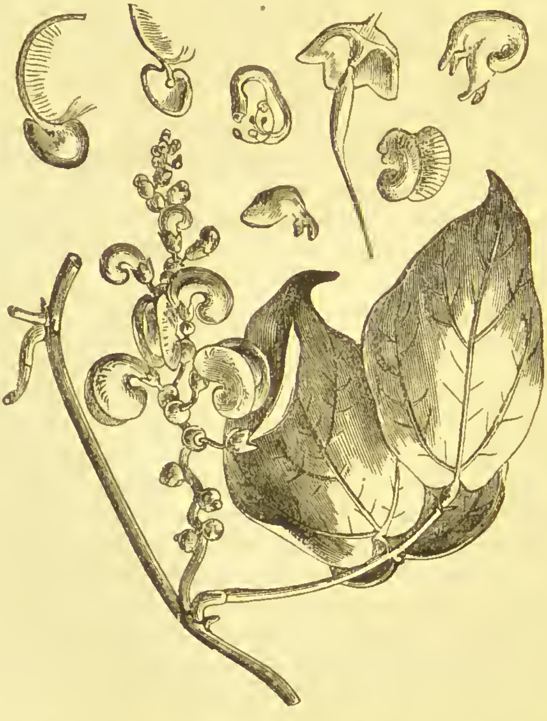


Fig. 112.—*Physostigma venenosum.* Of the detached parts, the first fig. on the right is the keel; the next in line, the calyx and young pod; that below these two, the standard; that to the left of the calyx and pod, the stamens; the fig. below this, one of the wings; the two figs. on the extreme left, two views of the bearded style and hooded stigma.

Characters.—Stem 2 inches in diameter, and often 50 feet long, with intertwined branches. *Leaves* trifoliate, leaflets ovate, acuminate. *Racemes* axillary, the flowers springing from knots on the tortuous peduncle. *Corolla* papilionaceous, purplish-pink, veined. *Vexillum* large, bilobate, recurved.

Stamens, 10 diadelphous. *Stigma* with a large sac or hood extending along the upper part of the convexity of the style. *Legume* 7 inches long, dehiscent, with the apex curved. *Seeds* 2 or 3.—*Balfour, Trans. Roy. Soc. Edin.* vol. xxii. p. 305.

1. **Physostigmatis Faba,** *P.B.* *Calabar Bean.*

The seed of the plant above described, from Western Africa,

Characters and Composition.—About the size of a large horse bean, with a very firm, hard, brittle, shining coat of a brownish-red, pale-chocolate, or ash-grey colour. Irregularly kidney-shaped, with flat surfaces, and a rounded border, which is for the most part boldly curved, and there marked with a broad furrow, with the central raised raphe in the centre and ending at one extremity in the micropyle. The kernel consists of two cotyledons, weighing on the average 46 grains; hard, white, and pulverisable; of a taste like that of edible leguminous seeds. It yields its properties to alcohol, and imperfectly to water.

The kernel is composed of 48 per cent. of starch; 23 per cent. of legumin; $\frac{1}{2}$ to $\frac{1}{3}$ per cent. of fatty oil; of mucilage, a little sugar, and of the active principle *physostigmine*, *physostigmia*, or *eserina*. The entire seed yields 3 per cent. of ash, which is chiefly phosphate of potash. An infusion of the shell of the seed has an orange colour, which is intensified by caustic potash. The colourless aqueous infusion of the kernel also assumes the same colour with caustic alkali.

Physostigmia, according to Hesse, has the composition, $C_{30}H_{21}N_3O_4$; is an amorphous, colourless, and tasteless substance of alkaline reaction; soluble in alcohol, æther, chloroform, benzol, and to some extent in water. It is soluble in acids. On exposure to the air the solution becomes red or intensely blue, from partial decomposition of the alkaloid. It fuses at 112°, and reddens from commencing decomposition at 212°.

It is procured by dissolving the extract in a little water, adding excess of bicarbonate of soda, evaporating to dryness, and dissolving out the liberated alkaloid by æther or benzol. Vée and Leven (*Comptes Rendus*, lx. 1194), obtained the alkaloid from the powdered unpeeled seeds, by a process similar to that adopted by Hesse, in the form of colourless rhomboidal crystals, having a bitter taste, and melting at 195°. In other respects it agrees with the amorphous alkaloid. Its aqueous solution reddens on exposure, and it neutralises acids, forming soluble salts. These observers called this body eserine, but Tison and others regard it as pure physostigmia.

Action and Uses.—The action of Calabar bean appears in the main to be identical with that of hemlock, producing in the early stage complete paralysis of the voluntary muscles, followed by impairment of the involuntary movements, and if the dose be sufficient, paralysis of the centres of the respiratory movements, and death. The intellect, the organs of speech, sense, and apart from the derangement of accommodation of the eye and the ear, and common sensation, appear to remain intact. The heart is of course secondarily affected, when the breathing is embarrassed, as it is under the full influence of conium or of aconite, but it would appear that it is earlier and more directly affected by Calabar bean than by these drugs. The action of physostigma is less simple than that of conium; for it not only produces complete muscular reaction, but even moderate doses generally cause contraction of the pupils, purging, nausea, and sometimes vomiting,—effects which are compounded of those of conium and some irritant-depressent, such as nicotia. The myosis cannot possibly be regarded as the result of stimulation of the third nerve, and it may therefore be assumed to be the effect of a depression of the sympathetic greater than that of the third nerve. If this view be correct, and it is corroborated by the experiments of Fraser, Bernstein, and others, the lethal effects of the drug must be attributed to syncope from paralysis of the cardiac sympathetic.

Locally applied, *contraction of the pupil* is the invariable effect of Calabar bean; and the drug is turned to useful purposes in affections of the third nerve, resulting in undue dilatation of the pupil. It has been freely used in the treatment of *strychnia poisoning* and *tenanus.* About one-half of the cases of the last-named disease so treated have recovered, which cannot be regarded as a satisfactory result. Owing to its depressent action on the heart, it is not so appropriate a remedy in these diseases as conium. It has been largely used in the treatment of other nervous affections, especially *chorea* and *epilepsy*, but without very encouraging results. M. Bouchat, however, states that the daily subcutaneous injection of physostigmia will cure chorea on the average in 10 days. He states that the effects of the subcutaneous injection of a full medicinal dose ($\frac{1}{14}$ of a grain) on children are great pallor, nausea, and salivation, with occasional vomiting, actively-dilated or contracted pupils, abundant perspiration, with enfeeblement or even paralysis of the diaphragm, and intense prostration. He gives the $\frac{1}{14}$ to the $\frac{1}{35}$ of a grain of the sulphate internally, and states that $\frac{1}{28}$ of a grain may be injected hypodermically two or three times a day without disagreeable effects (*Bull. génér. de Therap.* 1875). It is, I think, doubtful whether he used the pure alkaloid.

Dose.—Of the powdered bean, 1 to 4 grains; of the alkaloid physostigmia, to produce decided physiological effects, $\frac{1}{10}$ of a grain by the mouth, or $\frac{1}{40}$ by the subcutaneous tissue.

Treatment of Poisoning by Calabar Bean.—Diffusible stimulants; the hypodermic injection of the $\frac{1}{50}$ of a grain of sulphate of atropia, to be repeated if necessary at the end of two hours; and artificial respiration. The experiments of Dr T. Fraser on the "Antagonism between the Actions of Atropia and Physostigma" (*Trans. Roy. Soc. Edin.* vol. xxvi.), gives great support to the view that the latter destroys life by paralysis of the cardiac sympathetic.

2. **Extractum Physostigmatis**, *P.B.* *Extract of Calabar Bean.*

Preparation.—Macerate 1 pound of *Calabar bean* in coarse powder, in 1 pint of *rectified spirit* for forty-eight hours, agitating occasionally, then transfer to a percolator, and exhaust the powder by slow percolation, with 3 pints more of rectified spirit. Press out the spirit from the mass, and filter. Mix the liquors, distil off most of the spirit, and evaporate the residue by a water bath to the consistence of a soft extract.

Dose.—$\frac{1}{16}$ to $\frac{1}{4}$ of a grain. It appears that the extract is very variable, and this is probably due to deterioration of the bean, the kernels of which are often found shrivelled, discoloured, and mouldy. Dr O'Leary took 140 grains of the extract in eighty-six hours, and for a short time 4 grains every hour, during an attack of traumatic tetanus; and Dr Eben. Watson has given even larger doses to patients suffering from the same affection. To cause contraction of the pupil, a few drops of a solution of 4 grains in 1 ounce of water, or a filmy disc of gelatin prepared with this solution, may be placed between the eye and the lower lid.

INDIGOFERA TINCTORIA, *Linn.* **Common Indigo.**

This small shrubby plant is indigenous to the tropical parts of the East and West Indies, and Africa. It is extensively cultivated in Bengal, Tirhoot, and other parts of India.

Characters.—*Stem* erect, pubescent. *Leaves* pinnate; leaflets 4–5 pairs, ovate. *Flowers* papilionaceous, in erect axillary racemes. *Stamens* 10, diadelphous. *Legume* nearly cylindrical, curved, deflexed. *Seeds* about 10, truncated.—*Wight, Icon. Pl. Ind. Orient.* vol. ii. p. 365.

This plant, and several of the same genus, and other genera, *e.g.* *Wrightia tinctoria*, *Baptisia tinctoria* (wild indigo of the North American States), and our indigenous *Isatis tinctoria*, of the Brassicaceous family, have a yellow acid juice, which, under the influence of a ferment or on simple exposure to the air, becomes blue from the formation of indigo.

1. **Indigo**, *P.B.* $C_{16}H_5NO_2 = 131$ or $C_8H_5NO = 131$.

A blue pigment, prepared from various species of Indigofera.

Preparation.—The green plants are cut down in June and July just before flowering, and placed in large wooden or brick troughs, pressed closely together, and covered with water. After a few hours fermentation begins, and is allowed to continue from twelve to fourteen hours. The temperature rises to 100° and 110°, ammonia and carbonic anhydride are evolved, the surface becomes covered with a blue irridescent film, and the liquid acquires the colour of sherry. It is then drawn off and agitated briskly, when the indigo separates as a deep blue granular powder. This is allowed to settle, and the supernatant liquid being drawn off, the sedimentary portion is heated to the boiling point, and thrown on a calico filter. The pasty indigo is then removed from the filter, pressed, cut into cakes, and dried.

From the observations of Schunck (*Manch. Mem.* vol. xii. p. 177), on Isatis, it appears that the indigo-producing constituent is *indican*, $C_{26}H_{33}NO_{18}$, for he found that this body when heated with sulphuric or hydrochloric acid is resolved into *indigo*, *indigo-red*, and *indiglucin*, $C_6H_{10}O_6$, a variety of sugar, thus:—$C_{26}H_{33}NO_{18}+H_2O=C_8H_5NO+3C_6H_{10}O_6$. Indican is a yellow, amorphous, deliquescent body, soluble in water, alcohol, and æther. The solution becomes bright yellow when mixed with alkalies or alkaline earths, and when boiled with them evolves ammonia. The aqueous solution is decomposed by heat, and no longer furnishs indigo blue when boiled with acids but *indigo-brown*.

Characters.—In cubic cakes, of a deep blue colour; when rubbed by a smooth hard body it assumes a bronzy hue. Besides indigo (*indigo-blue* or *indigotin*), which is the chief constituent, it contains some impurities and variable proportions of indigo-red and indigo-brown. The latter is separated by boiling alcohol, the former by caustic potash. Indigo-blue is metameric with benzoyle cyanide. It is insoluble in water, alcohol, æther, the fixed and volatile oils, and dilute acids and alkalies. It fuses at 550°, sublimes in purple vapours, and, if the air be excluded, is deposited in copper-coloured 6-sided prisms. It is thus distinguished from Prussian blue. By destructive distillation it yields ammonic carbonate and cyanide, and aniline. Deoxydising agents and ferments convert insoluble indigo-blue into soluble *white-indigo*, C_8H_6NO, which absorbs oxygen on exposure to the air, and again returns to indigo-blue. This occurs in the process of dyeing. 1 part of powdered indigo, 2 of ferrous sulphate, 3 of slaked lime, and 200 of water, form an alkaline colourless solution of white indigo, the whole of the iron being precipitated as peroxyde. On exposure to the air this liquid becomes covered with a blue film, and pure indigo is gradually deposited, and if wool or vegetable fibre be soaked in the colourless fluid and exposed to the air it is permanently and persistently dyed deep blue.

Pharmaceutical Use.—As a test for free chlorine in the form of the following solution:—

2. Solution of Sulphate of Indigo, *P.B.*

Preparation.—Mix 5 grains of *dry indigo* in fine powder with 1 fluid drachm of *sulphuric acid* in a test tube, and apply the heat of a water bath for an hour. Pour the blue liquid into 10 fluid ounces of sulphuric acid, agitate the mixture, and when the undissolved indigo has subsided, decant the clear liquid into a stoppered bottle. A solution of *sulphindylic acid*, $HC_8H_4NSO_4$, is formed in the above process. The blue colour is discharged by free chlorine.

Other Medicinal Products of the Leguminosæ.

1. The bark of *Erythrophlœum judiciale*, the Sassy bark tree of Sierra Leone, possesses narcotic and irritant properties, and is used in trial by ordeal among the natives of the Gold Coast. This tree belongs to the sub-order Mimoseæ.

2. The bark and seeds of the Laburnum (*Cytisus laburnum*) are replete with a principle which resembles the foregoing in its action. According to Christison, this principle, *cytisin*, possesses irritant and narcotic properties. But in the cases of poisoning by the bark

of the root (which from its yellow colour has been mistaken by children for liquorice) the symptoms have been uniformly those of a narcotic. This was fully illustrated in a remarkable case of poisoning, in which 58 boys partook of the root. The effects were somnolency, varying from the least degree to complete stupor, pallor, coldness, and staggering. In two there was some jactitation of the limbs. They all recovered under the treatment appropriate for opium narcosis (*Dr Vallance, Brit. Med. Journ.* Sept. 1875).

3. The *Baptisia tinctoria*, or Wild indigo of the Northern States, a plant of the papilionaceous tribe, is used to obtain a blue dye, and employed in medicine by the American practitioners called "Eclectics." A resinous extract of the root, called *baptisin*, is made by preparing a tincture with strong alcohol, and precipitating this with water. It is given in doses of 1 to 2 grains. It is stimulant in small, nauseant and emetic in large doses. It is reported to be of use in dysentery, putrid fevers, and gangrenous inflammations, as an "antiseptic." Further experiment is needed to determine its real value.

4. *Araroba, Goa Powder*, or *Poh di Bahia.*—This is said to be the pith of a leguminous tree. It has lately been brought under the notice of the profession as a remedy for diseases of the skin which are due to fungi. It is a coarse molecular powder, of a light yellow colour, mixed with fragments of wood. It has an earthy appearance; the larger fragments are light, and sometimes present when broken a stratified appearance, and when rubbed on the nail or any other smooth surface they soon acquire a brilliant polish. It has a slightly astringent resinous taste, leaving a faintly bitter impression. According to Dr Attfield (*Pharm. Journ.* March 1875, p. 721), it is composed of about 7 per cent. of a glucoside and bitter matter, 2 of a resinoid body, 5½ of woody fibre, ½ per cent. of ash composed of sulphates of potassium and sodium and silicate of alumina, and of 80 to 84 per cent. of *chrysophanic acid* (see pp. 466 and 650). It is thus remarkable for the large quantity of the last mentioned constituent, which possesses a feeble purgative action.

The powder, "chrysarobin," as it has been termed, is used in the form of ointment (20 grains moistened with 10 drops of acetic acid mixed with 1 ounce of lard, *Dr Da Silva*) in ringworm and allied affections of the skin.

4. *Cæsalpinia Bonducella*, Roxb., or *Guilandina Bonducella* of Linnæus (*Lam. Illus.* t. 36).—The seed of this prickly, climbing shrub is an article of the Pharmacopœia of India. Bonduc seeds, or grey nicker nuts, as they are sometimes called, are ovoid and slightly compressed, from ½ to ¾ inch in diameter, of a bluish-grey tint, smooth, but marked by faint horizontal lines of a deeper hue. The testa is hard and thick, and constitutes about half the weight of the seed; the kernel is bitter, and contains a large quantity of fixed oil, resin, and a bitter principle. The seeds and root of this plant are reported to be powerfully antiperiodic and tonic. The dose of the former is 15 to 30 grains, and that of the latter 10 grains, repeated twice or thrice in the day.

6. *Arachis hypogæa*, Linn., or Ground Nut (*Lam. Illus.* t. 615), is also an article of the Pharmacopœia of India. The seeds yield by expression from 40 to 50 per cent. of fixed oil (Arachis oil), which in blandness and delicacy of flavour rivals olive oil. The sp. gr. is ·918; it becomes turbid about 37°, and concretes at about 25°. It becomes rancid on exposure to the air, but does not dry. It consists of the glycerides of oleic acid, palmitic acid, hypogæic acid $C_{16}H_{30}O_2$, and arachic acid $C_{20}H_{40}O_2$. It may be employed instead of olive oil.

7. *Abrus precatorius*, Linn., the Indian Liquorice (*Lam. Illus.* t. 608). The root of this plant has been proposed as a substitute for that of glycyrrhiza, to which, however, it is inferior. It is inodorous, sweetish, and mucilaginous, and its properties appear to depend on glycyrrhizin. The beautiful little scarlet and black seeds of this plant (each weighing about 2½ grains) were formerly used as weights by the Hindu jewellers and druggists.

8. *Trigonella Fœnum-græcum*, Linn., the Fenugreek.—An erect annual plant, about 1½ foot high. It is cultivated as fodder, and furnishes small, oblong, angular, aromatic, mucilaginous seeds about the ⅛ of an inch long, and of a light-brown colour. They resemble cumin in taste, but have a richer, and at the same time a more delicate flavour, with a trace of bitterness. They are used in India as food and condiment, and are one of the constituents of curry powder.

ANACARDIACEÆ, *R. Brown.* Terebinths.

These plants, according to Lindley's definition, are Rutal exogens, with apocarpous fruit, and a single ovule rising by the funicle from the base of the cell. They are characterised by their resinous, gummy, or milky juice, often with a strong turpentine odour and taste. The seeds of many species, *e.g.*, *Anacardium occidentale*, or Cashew nut, yield abundance of bland oil and gum. The order includes the Mango (*Mangifera Indica*).

1. PISTACIA LENTISCUS, *Linn.* The Mastiche Tree or Lentisk.

Mastic and the tree yielding it (*Σχινος* of the Greeks) were well known to the ancients, the latter being a native of the Grecian Archipelago and of the Mediterranean region.

Characters.—A *shrub* about 12 feet high, distinguished from the terebinth tree (*P. terebinthus*) by the absence of a terminal leaflet. *Leaflets* 8 to 10, small, oval, lanceolate; petiole winged. *Flowers* diœcious, small, apetalous, in axillary racemes, near the ends of the branches. *Males* in compound amentaceous racemes, each supported by a bract. *Calyx* small, 5-cleft. *Stamens* 5, nearly sessile. *Females* in more lax compound racemes. *Calyx* 3 to 4-cleft. *Ovary* 1-celled. *Styles* 3. *Stigmas* 3, spreading. *Fruit* a small, roundish drupe, brownish-red. *Seed* solitary, erect, exalbuminous. *Cotyledons* fleshy, very oily. *Radicle* superior.—*Steph. and Church*, pl. 130.

This shrub is cultivated in the isle of Scio, whence the mastic is chiefly obtained by transverse incisions made in the trunk and principal branches in the month of July. Some of it adheres to the tree in the form of tears, and some falls on the earth, and is collected in August.

1. Mastiche, *P.B.* *Mastich.*

A resin produced, as stated, in the island of Scio (Chio).

Characters.—In small, smooth, yellowish tears, about the size and colour of grains of maize, brittle and dusty, with powder derived from attrition. It becomes soft and ductile when chewed (a temperature of 227° is required to melt it), and has a faint agreeable resinous odour and flavour. About 90 per cent. is soluble in alcohol; the remainder is soluble in æther and in turpentine. It is wholly soluble in æther, and in about 5 parts of oil of cloves, forming a clear solution.

Action. Uses.—Little used, except as a masticatory in the East; sometimes in fumigation; most frequently by dentists for stuffing decayed teeth. It forms an ingredient of *Eau de Luce*, for which the *Tinctura ammoniæ composita* (mastiche 120 grains, stronger solution of ammonia 16 fluid ounces, rectified spirit 9 fluid drachms, and oil of lavender 14 minims) of a former Pharmacopœia was intended as a substitute. A solution of mastic in turpentine or alcohol is commonly used as a varnish.

2. PISTACIA TEREBINTHUS, *Linn.* The Chian Turpentine Tree.

The terebinth was well known to the ancients. It is the *alah* of the Old Testament, translated *oak*, *terebinth*, &c., *τέρμινθος* of the Greeks, and the *butm* of the Arabs. It is found in the south of Europe, Asia Minor, Syria, and the north of Africa.

Characters.—A *tree* 20 to 40 feet high. *Leaves* pinnate, with an odd one. *Leaflets* about 7 or 9, ovate, lanceolate, round at the base, acute, mucronate, reddish-coloured when young, afterwards of a dark-green colour. *Inflorescence* a large compound panicle. Scales of the *male flower* covered with brown hairs. *Anthers* yellowish. *Stigmas* of a crimson colour. *Fruit* purple, roundish, about the size of a large pea. Horn-shaped galls are produced on these trees.

The Turpentine of this tree is obtained in the island of Chio, by making transverse incisions into the bark of the trees, of which each yields only a few ounces, and the whole island not more than 1000 pounds. The harvest is from July to October. The juice issuing from the wounds is allowed to fall upon smooth stones, from which it is scraped, and purified by being melted in the sun and strained into bottles. It used to be taken chiefly to Venice, where it was in request for making the far-famed Theriaca. Chian turpentine is a pellucid liquid of a yellowish colour, having the consistence of honey, tenacious, with an agreeable terebinthine smell, and moderately warm taste. Exposed to the air it thickens, and becomes hard from the loss of volatile oil, of which it contains about 15 per cent. From its scarcity and high price, it is usually adulterated with common turpentines.

Action. Uses.—Stimulant and diuretic, like the coniferous turpentines.

Other Anacardinaceous Products.

1. *Pistacia vera.*—The Pistacia nut tree extends from Syria to Bokhara and Cabul. It has long been introduced into the south of Europe, and is remarkable for its green-coloured kernels enclosed within a reddish-coloured testa, and furnished with a very distinct funicle. The kernels are pleasant, often eaten at dessert, either raw or fried with pepper and salt. They yield a large quantity of bland oil, and form an emulsion with water.

2. *Rhus toxicodendron* has a milky, extremely acrid juice, which becomes black on drying, and exhales a volatile poison. It produces feverish symptoms, with excessive irritation of the cutaneous and mucous surfaces, attended with erythema and swelling, and general pains.

3. The bark and fruit of *R. glabrum* (*Sumach*) is considered febrifuge.

4. The pericarp of the *Anacardium occidentale* (Cashew-nut) is replete with an acrid oil, which produces tingling and swelling of the lips. The nut itself contains a sweet bland oil and a considerable proportion of gum.

5. The *Mangifera Indica* yields the well-known mango fruit, which rivals the peach in delicacy of flavour and refreshing acidulous taste. In the unripe state it tastes strongly of turpentine.

BURSERACEÆ, *Kunth.* Balsamads.

These plants are distinguished from Terebinthaceæ by their many-celled germen, and by their ovules being in pairs, and by their plaited convolute cotyledons. They are all found in tropical parts of the world. The juice of these plants is famed for its balsamic odour and stimulant properties, *e.g.* Balsam of Gilead, Olibanum or Frankincense, Myrrh, Bdellium, Elemi, &c.

BOSWELLIA, SPECIES VARIÆ. Olibanum or Frankincense Trees.

Although the produce of these trees has been known from the highest antiquity, we are still imperfectly acquainted with the species producing it. Birdwood (*Trans. Lin. Soc.* vol. xxvii. tab. 29, 30, 31, and 32) figures four plants. Two of these, "Mohr madow" of the Soumalis, and "Maghrayt d'shechaz" of the Maharas, he regards as varieties of *B. Carterii.* The third is *B. Bhau-Dajiana* (Bird.), the "Mohr add" of the Soumalis. The fourth plant is *B. Frereana* (Bird.), or the "Yegaar" of the Soumalis. The Mohr madow yields the olibanum called *Lubân Bedowi*, or *Lubân Sheheri.* The Yegaar furnishes that collected and sold as *Lubân Maitie* or *Lubân Meyeti.* It is distinct from the other kinds of olibanum as being wholly free from gum. It is usually in stalactical masses, which break with a choncoidal fracture. It is sometimes called "African Elemi," but is known from true elemi by the absence of crystallisable resin.

The *B. thurifera,* Colebr. (*B. glabra* and *B. serrata,* Roxb.), which was formerly regarded as the source of the olibanum of commerce, appears to furnish little or none of it. Dr Birdwood says that he has always failed to get it in tears, and that it is in the form of soft runnings, like those of a wax candle. In Kandeish it is sold under the name of "*Dup-Salai*," or incense of *Salai* or *Saleh*. *B. papyrifera*, Rich. (*Plösslea floribunda*, Endl.), a native of Abyssinia and Sennaar, also furnishes a variety of olibanum; but very little of it is collected.

Of these plants *B. Carterii* and *B. Bhau-Dajiana* may be regarded as the chief sources of the olibanum of commerce. The species of Boswellia have a strong resemblance to each other, and the genus is well represented by the Indian species *B. thurifera*.

B. THURIFERA, Colbr.—A *tree* with a papyraceous bark, abounding in gum-resin, the lower branches bare. *Leaves* deciduous, alternate, imparipinnate, crowded towards the ends of the branches. *Leaflets* 9 pairs, serrated, like the stalks and young branches, pubescent. *Flowers* in long racemes, arising singly from the axils of the leaves, or together from the ends of the branches. *Calyx* small, 5-toothed. *Petals* 5, narrow at the base, patent, imbricate. *Stamens* 10, inserted with the petals under an annular or cup-shaped crenulated disc. *Ovary* 3-5 celled. *Style* short. *Stigma* 3–5, lobed. *Ovules* 2, pendulous. *Drupe* 3–4–5, cornered and valved, septicidal. *Cells* 1-seeded. *Seeds* compressed, with a membranous testa produced into a margin. *Cotyledons* contortuplicate, multifid.

B. CARTERII, Birdw., has from 7–10 pairs of leaflets, ovate-oblong, undulate or crenate-undulate, expanded at the base; *racemes* simple, fasciculate, shorter than the leaves; *fruit* ¼ to ½ inch long, ovate-obtuse.

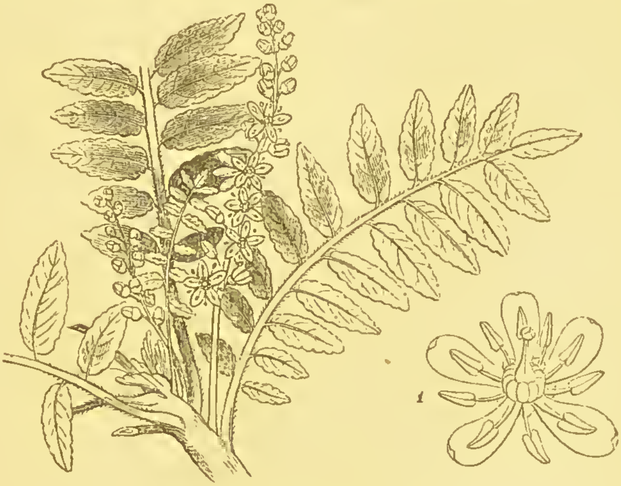


Fig. 113.—*Boswellia thurifera.*

They grow at an elevation of 2000 to 3000 feet, in the rocky regions of the south coast of Arabia, and on the limestone mountains which extend westward from Cape Gardafui (*Promontorium aromatum* of the ancients), through the Soumali country on the opposite coast of Africa, in both of which regions they adorn the limestone cliffs with their elegant foliage, and render the air fragrant with their balsamic exhalations.

1. Olibanum, Gr. Λίβανος, frankincense; Arab. *Lubân*, milk, and Heb. *Lebonah*, milk.

A fragrant gum-resin, obtained from species of Boswellia above mentioned, in the following manner:—About the beginning of March the Bedouins visit all the trees in succession, and make a deep incision in each; peeling off a narrow strip of bark for about five inches below the wound, a copious milky juice exudes. At the end of a month another and a deeper incision is made in the same place, and repeated at the end of each month. Soon afterwards the exudation, having acquired a proper consistence, is collected by parties of men and boys. The clear globular masses are kept separate from the remainder, which is attached to the bark. During the hot season the mountains are visited in this manner every fortnight, the trees producing larger quantities as the season advances, until the middle of September, when the first shower of rain closes the gathering of that year. At the close of the north-east monsoon the Banians of Kattiawar and Bombay arrive on the coast, and the Bedouins come down from the interior to sell their olibanum (Cruttenden, *Trans. Bombay Geo. Soc.* vii.). Cruttenden estimates that the annual export from this coast is,—to Bombay, 377 tons; the Red Sea, 235 tons; and to Arabia, 120 tons.

In Arabia the gum is procured as in the time of the Sabæans (Theofrastus, *Hist. Plant.* book ix. ch. 4), by making longitudinal incisions through the bark in the months of May and December. On its first appearance it comes forth white as milk, and according to its fluidity finds its way to the ground or concretes on the branch, from whence it is collected by men and boys employed for the purpose by the different families who own the land on which the trees grow (Carter, *Journ. Bombay branch Roy. Asiat. Soc.* vol. ii.).

Characters and Composition.—Pyriform trees, angular fragments or stalactitic masses, more or less agglutinated, covered with white dust, produced by attrition of the particles, translucent or milky opaque, colourless, or more commonly of a yellowish colour, with occasionally a greenish tinge; odour and taste sweetly terebinthaceous, slightly bitter. Cold water converts it into a whitish pulp, and, with friction, into an emulsion. It is composed of about 33 per cent. of *gum*, 5 per cent. of *volatile oil* resembling oil of turpentine but more fragrant, and 62 per cent. of *resin*, having, according to Hlasiwetz, the composition $C_{40}H_{30}O_6$.

Action and Uses.—Stimulant, diuretic, and diaphoretic in chronic affections of the mucous membranes, but chiefly used as a constituent of plasters, and as a fumigation. "Nothing so quickly clears your bed in Bombay of mosquitoes as burning a little olibanum or myrrh in it" (Birdwood, *op. cit.*)

Dose.—30 to 60 grains, in the form of emulsion.

THE ELEMI TREE.

Most of the elemi of commerce is imported from Manila. The tree which furnishes the oleo-resin grows in the province of Batangas, in the island of Luzon. It is called by the natives *Abilo*, and by the Spaniards *Arbol a brea* or *pitch-tree.* Blanco (*Flora de Fili-*

pinas, Manila, 1845, 256) has described this tree as *Icica abilo.* Mr Bennett, after careful study of this description, concludes that it cannot be a species of Canarium (*Hanb. and Flück. Pharmacograph.* p. 130). The following trees are known to furnish elemi:—

1. Canarium commune, Linn., *Java almond* or *Elemi tree.*—A small tree. *Leaves* stipulate, compounded of 7-11 ovate-oblong entire leaflets on long pedicels. *Flowers* in terminal panicles, polygamous. *Calyx* 3-lobed, campanulate unequal, externally silky. *Petals* 3, concave. *Stamens* 6, inserted with the petals under an urceolate disc. *Ovary* 3-celled. *Stigma* 3-lobed. *Drupe* oblong, black.—*Rumph. Amb.* vol. ii. plate 47; *Kœnig. An. Bot.* t. 7, f. 2.

2. Amyris or Elaphrium elemifera, Royle.—This tree grows at Oaxaca, in Mexico. It is 12 feet high, twigs smooth, somewhat angular. *Leaves* exstipulate, imparipinnate, rachis winged; *leaflets* 3–10 pairs, variable in form, entire, or irregularly toothed, the lower pairs ternately or pinnately cut, smooth and shining. *Drupes* ovoid, splitting into two valves, and displaying the blackish apex of the seed, the lower part of which is enveloped in a reddish-yellow aril-like body. *Seeds* single, one being abortive, ovate. *Cotyledons* contortuplicate.

This is the source of *Mexican* or *Vera Cruz Elemi* which is rarely seen now.

3. Icica, species variæ.—*I. Icioariba, I. heterophylla* (Decand.), *I. heptaphylla, I. Guianensis, I. altissima* (Ambl.), and *I. caranna*, all furnish *Brazilian Elemi.*

4. Colophonia Mauritiana (Decand.), affords, according to Hanbury, a fine *Mauritius Elemi.*

1. Elemi, *P.B. Elemi.*

It is remarkable that with this great variety in the source of elemi, the drug itself should present a very uniform composition, and but little variability of physical characters.

It is defined in the Pharmacopœia as a concrete-resinous exudation, the botanical source of which is undetermined, but is probably *Canarium commune*, Linn., chiefly imported from Manila.

Characters, Composition, and Test.—A soft, unctuous, adhesive mass, becoming harder and more resinous by age, of a yellowish-white colour, with a rather fragrant, fennel-like odour, almost entirely soluble in rectified spirit.

Manila elemi is composed of 10–12 per cent. of a fragrant colourless neutral *volatile oil;* 25 per cent. of *elemin* or *amyrin*, a crystalline resin of snowy whiteness, easily obtained as a residue after washing crude elemi with a moderate quantity of cold alcohol, and recrystallising from a solution in hot alcohol; about 60 per cent. of uncrystallisable resin, soluble in cold alcohol; and from 1–2 per cent. of *bryoidin* and *bréidine*, crystalline bitter, neutral principles, feebly soluble in cold water, but freely in hot water and in alcohol and æther.

Elemi is known from olibanum and other resins by its partially crystalline structure, revealed by the microscope on treating it with cold alcohol,—the white residuum being composed of acicular crystals of amyrin.

Action and Uses.—It is applied externally as a stimulant. The ointment of arcæus contained elemi.

2. **Unguentum Elemi,** *P.B.* *Elemi Ointment.*

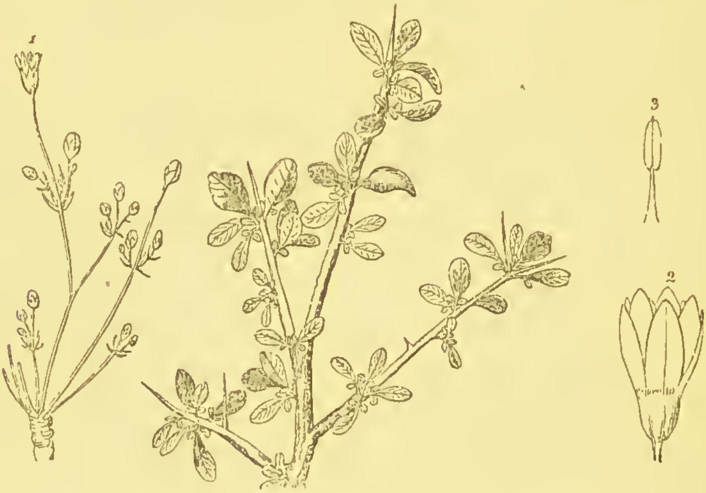
Contains 1 part of the oleo-resin in 5 parts. It is prepared by melting together ¼ ounce of *elemi* and 1 ounce of *simple ointment*, straining through flannel, and stirring until the ointment solidifies.

BALSAMODENDRON MYRRHA, *Ehrenb.* The Myrrh Shrub.

Synonyms.—*B. opobalsamum*, Kth.? *B. Gileadense*? *B. Ehrenbergianum*, Berg. Arab. *Karbeta.*

This shrub forms the chief underwood of the forests on the Arabian and African shores of the Red Sea, about 9° to 16° latitude, extending as far inland as the mountains Djara and Kara on the one continent, and the mountains of Abyssinia on the other.

Characters.—A *shrub* with squamose spinescent branches (fig 114.) Bark pale ash-grey, wood yellowish-white, both having a peculiar odour. *Leaves* ternate; *leaflets* obovate, obtuse, obtusely denticulated at the apex. *Flowers* solitary, nearly sessile. *Calyx* 4-toothed. *Petals* 4. *Stamens* 8, inserted under a cup-shaped disc. *Ovary* 2-celled. *Style* short, 4-lobed. *Drupe* ovate, acuminate, a little larger than a pea, smooth, brown, with the minute calyx persistent at the base.—*Nees von Esenb. Plantæ Medicinales,* ii. 1828, tab. 355.



Fig, 114.—*Balsamodendron Myrrha.* 1, 2, 3, *B. Kataf.*

According to Ehrenberg, myrrh exudes from the bark like cherry-tree gum. It is of oily consistence at first, then buttery and yellowish white. It gradually assumes a golden tint, and ultimately becomes hard and reddish. Mr Johnston also, in his travels through Adel to Abyssinia (i. p. 247), in treating "of the tree that yields this useful drug, myrrh," says, "there are in the country of Adel two varieties; one a low, thorny, ragged-looking tree, with bright-green leaves, trifoliate, and an undulating edge, is that which has been described by Ehrenberg" (see the annexed figure, 114). "This produces the finest kind of myrrh in our shops." This may be either the above *B. Myrrha* or one of the forms of *B. opobal-*

samum. "The other is a more leafy tree, if I may use the expression, and its appearance reminded me exceedingly of the common hawthorn of home, having the same largely serrated, dark-green leaves, growing in branches of four or five, springing by several leaf-stalks from a common centre. The flowers are small, of a light green colour, hanging in pairs beneath the leaves, and in size and shape resemble very much the flowers of our gooseberry tree, the eight stamens being alternately long and short, the former corresponding to the four partial clefts in the edge of the one-leafed calyx. The style is single. The fruit is a kind of berry, that when ripe easily throws off the dry shell in two pieces, and the two seeds it contains escape. The outer bark is thin, transparent, and easily detached; the inner thick, woody. When wounded, a yellow, turbid fluid (the gum-myrrh) immediately makes its appearance. Naturally, the gum exudes from cracks in the bark of the trunk near the root, and flows freely upon the stones immediately underneath. Artificially, it is obtained by bruises made with stones."

This plant, judging from the specimens deposited by Mr Johnston in the British Museum, corresponds exactly with one, also in the same collection, obtained by Mr Salt in Abyssinia, *Balsamodendron Kua* of Mr Brown's MSS., and of which Mr Salt says, he obtained from it a gum much resembling the myrrh. From the observations and statements of Cruttenden (*Trans. Bombay Geog. Soc.* vii. p. 123) and Vaughan (*Pharm. Journ.* xii. p. 226, 1853), it appears that the greater part of the myrrh of commerce is collected in the Soumali country and on the opposite coast, east of Aden. It is brought to the great fairs held at Berbera, Zeyla, and Massowah, where it is purchased by the Banians of India, and carried to Bombay.

1. **Myrrha,** *P.B.* *Myrrh.*

Heb. *Mur*, Egypt. *Bola*, Arab. *Heera Bôl*, Gr. Μυῤῥα and Σμύρνα. A gum-resinous exudation from the stem of *B. myrrha:* collected in Arabia Felix and Abyssinia.

Characters and Composition.—Irregularly-shaped tears or masses, varying much in size; somewhat translucent, of a reddish-yellow or reddish-brown colour; fractured surface irregular, dull, somewhat oily; odour heavy, aromatic, agreeable; taste bitter, and slightly acrid.

When heated, myrrh first softens, then burns, leaving a black, spongy ash. Triturated with water it forms an emulsion. It is composed of 34 per cent. of a yellowish, rather viscid *volatile oil*, having a powerful odour of myrrh; from 40 to 65 per cent. of *gum*, soluble in water, and differing but little from arabin; and the remainder of *resin*, which, when moistened with alcohol and then with hydrochloric acid, assumes a violet hue, but far less brilliant than that displayed by galbanum under the same circumstances (Flückiger). It is soluble in caustic alkalies.

Adulterations.—Myrrh is mixed with various gums and resins, and with inferior kinds derived from other species of Balsamodendron, as

B. Mukul, Hook., and *B. pubescens*, Stocks, which are the source of *bdellium* or *false myrrh*. These species are common to the African and East Indian continents.

The first, found in the west of Africa, occurs also in the flat country of the Adel. It yields **African Bdellium**, or that imported into France from Guinea and the Senegal, according to M. Perrotet. M. Adanson, likewise, in his "Travels in the Senegal," mentions it by the name of *Niotout*, as producing bdellium. It yields the bdellium exported from the west coast of Africa. It is in roundish pieces of a dull dark-red colour, more moist than myrrh, and not brittle like it, softening even with the heat of the hand; bitter, and a little acrid in taste, with a less agreeable odour. It often has portions of the birch-like bark adhering to it.

Indian Bdellium also is furnished by *B. Mukul*, growing in Sindh, Rajpootana, Khandeish, and in the neighbourhood of Umber, 20 miles west of Aurungabad. The gum-resin is in brittle masses of a red, yellow, or brownish colour, sometimes transparent, having a bitter taste like myrrh, and a similar, but fainter and more agreeable odour. It has a similar composition. It is called by the natives *Googul* or *Guggur*.

Action and Uses.—Myrrh is a stimulant tonic to the mucous membrane, by virtue of which it checks the undue secretion of bronchorrhœa, leucorrhœa, and cystitis, and tends to excite the natural secretions of the alimentary and sexual organs. Hence it is beneficial in atonic dyspepsia, in amenorrhœa and chlorosis. It is a direct stimulant to ulcerated and irritably congested conditions of the mucous membrane, as in chronic gingivitis.

Dose.—10 to 30 grains, in the form of powder, pill, or emulsion.

Pharmacutical Uses.—A constituent of Decoctum aloes compositum (3 grains in 1 fluid ounce), Mistura ferri composita (6 grains in 1 fluid ounce), Pilula aloes et myrrhæ (1 in 6), Pilula assafœtidæ composita (1 in 3½), Pilula rhei composita (1 in 8).

2. **Tinctura Myrrhæ.** *P.B.* *Tincture of Myrrh.*

Contains 54½ grains in 1 fluid ounce.

Preparation.—Macerate 2½ ounces of *myrrh* in *coarse powder* for forty-eight hours in 15 fluid ounces of *rectified spirit*, with occasional agitation; then transfer to a percolator, and proceed as for tincture of aconite, and make 1 pint of the tincture.

Use.—A pleasant stimulant to relaxed or spongy gums, and a suitable preparation of myrrh for internal use.

Dose.—½ to 1 fluid drachm.

RHAMNACEÆ, *R. Brown.* The Buckthorn Family.

This shrubby order of perigynous exogens is known by the 4 or 5-fid valvate calyx, distinct cucullate petals, definite stamens placed opposite the petals, and erect seeds. The succulent fruits are cathartic, as Rhamnus; demulcent, as *Zizyphus Jujuba* and other species; nutritive, as *Zizyphus Lotus,* the Lote-bush or *Sadr* of the Arabs.

RHAMNUS CATHARTICUS, *Linn.* Buckthorn.

This smooth, shining, spreading shrub, the *Waythorn* or *Hartsthorn* of our ancestors, is indigenous in hedges and woods, and is found throughout Europe. It flowers in May and June, and ripens its fruit in September.

The berries have been employed as a purgative from the earliest times.

Characters.—Shrub, 10 to 12 feet high, with erect branches, and smooth shining bark like the cherry. The branches form a terminal thorn. *Leaves* irregularly disposed, oval, sharply toothed, with 3 or 4 simple prominent convergent veins. *Stipules* linear. *Flowers* usually diœcious, in clusters between the leaves, small yellowish-green. *Calyx* 4-cleft, valvate in æstivation. *Petals* 4, yellowish. *Stamens* equal to the petals, and opposite to them. *Ovary* 4-celled, ovules solitary, erect. *Fruit* a round black succulent berry, containing 4 triangular hard *seeds*, micropyle close by the hilum. *Embryo* foliaceous. *Cotyledons,* with the edges curved together, in the axis of horny albumin.—*Eng. Bot.* pl. 1629.

Characters and Constituents.—Buckthorn berries are about the size of rather small black currants, smooth, shining, and when quite ripe full of an intensely bitter-sweet greenish-purple watery juice, which becomes very sticky on evaporation. It contains a *green colouring matter*, which furnishes "sap-green," and is probably composed of the crystalline colouring matters described below; *sugar; a bitter purgative principle;* acetic and malic acids. The crystalline principles are *rhamnine* $C_{18}H_{22}O_{10}$, and *rhamnegine* $C_{24}H_{32}O_{14}$. They are both glucosides, and are resolvable into crystalline sugar and rhamnetin $C_{12}H_{10}O_5$. Rhamnine (rhamnetine and chrysorhamnine) crystallises from absolute alcohol in minute translucent yellow laminæ, which is but very feebly soluble in cold water, forming a pale yellow solution; it is insoluble in æther, but soluble in hot alcohol, and in alkaline solutions with the production of an orange colour. The addition of an acid precipitates it from the alkaline solution in a bulky gelatinous form. Rhamnegine is very soluble in water, but otherwise, both in physical and chemical properties resembles rhamnine. The proper action of buckthorn is probably altogether independent of these principles.

Action and Uses.—The juice of the fruit is a rapid and rather violent hydragogue purgative. Half a dozen of the fresh ripe berries are usually a sufficient dose. In my experience it produces a large quantity of flatus, and if this be imprisoned there is much griping. It is said to produce thirst also, but I have not myself noticed this effect.

1. **Rhamni succus,** *P.B. Buckthorn Juice.*

This is the recently expressed juice of the ripe berries. It is used in the following preparation :—

2. **Syrupus Rhamni,** *P.B. Syrup of Buckthorn.*

Preparation.—Evaporate 4 pints of *buckthorn juice* to 2½ pints, add ¾ ounce each of sliced *ginger* and bruised *pimento;* digest at a gentle heat for four hours, and strain. When cold add 6 fluid ounces of *rectified spirit;* let the mixture stand for two days, then decant off the clear liquid, and in this dissolve 5 pounds or a sufficiency of *refined sugar* with a gentle heat, so as to make the sp. gr. 1·32.

Dose.—½ to 1 fluid drachm.

RHAMNUS FRANGULA, *Linn.* Berry-bearing Alder.

This elegant arborescent shrub is frequent in thickets and the borders of woods. It is distinguished from the former by its tree-like habit, a dull grey bark, with longitudinal suberous eruptions. The leaves are *entire*, with about 7 pairs of nearly opposite parallel and very prominent veins; the flowers 5-*cleft*, and perfect; the style *simple;* the berry is round, *red*, and *fleshy* to within a short time of its ripening, it then becomes black and juicy; the seeds are 2 or 3, and *flat;* the cotyledons are also *flat*, and the embryo is wholly encased in albumin.

The ripe berries are larger than those of the preceding species, flattened, and present anteriorly a minute *umbilicated* dot, the site of the style. The seeds are surrounded by a beautifully reticulated, colourless, and nearly tasteless gelatinous pulp, the juice of which on exposure assumes a series of bright colours, from light yellow to deep blue.

The bark of the trunk and larger branches (*Cortex frangulæ* of the German Pharmacopœia) is brownish-yellow internally, compact, smooth, and fibrous, and of a pleasant sweetish taste.

Action and Uses.—The berries are inert, at least I find that 4 fluid drachms of a syrup prepared as directed for Syrupus rhamni, *P.B.*, from the ripe and fresh berries, collected on the last day of September of the present year, from fine bushes growing on an elevated common in Kent, has no laxative action. The bark has been used as a purgative for many years in Holland and Germany, and its action is said to be as certain as that of senna, and as mild as that of castor oil. A fluid extract, prepared by exhausting the bark with cold water and evaporating until it represents an equal weight of the dry bark, is an efficient preparation.

Dose.—As a gentle purgative, it may be given in the same doses as castor oil.

SAPOTACEÆ, *Endlicher.* The Sapota Family.

Rhamnal exogens, with monopetalous flowers, epipetalous stamens, ascending ovules, a short radicle, and amygdaloid cotyledons (Lindley). This small family of tropical plants furnishes many useful products beside gutta-percha. Thus the *Achras Sapota* and other species supply the Sapodilla plum; *Achras mammosa*, the marmalade; *Mimusops Elengi*, the Surinam medlar—all dessert fruits. The bark of *Achras Sapota* is used as a substitute for quinia; the seeds are aperient and diuretic. The kernels of *Lucuma mammosa* abound in hydrocyanic acid. The trunk of many of the species furnishes a milky juice like that of Isonandra, and the seeds of others yield abundance of oil.

ISONANDRA GUTTA, *Hooker*. **The Gutta-Percha Tree.**

This is a handsome evergreen tree, native of Borneo, Sumatra, and others of the East India Islands.

Characters.—A *tree* 60 feet high: *trunk* 2 or 3 feet in diameter. *Leaves* alternate, ovate-oblong, petiolate, entire, coriaceous, shining; on the under surface covered with a russet shining down. *Flowers* like those of the holly, in inconspicuous axillary clusters. *Peduncles* 1-flowered. *Calyx* 6-partite, lobes ovate-obtuse. *Corolla* with a short tube, sub-rotate, limb 6-partite, lobes spreading. *Stamens* 12, inserted into the throat of the corolla; *filaments* longer than the limb of the corolla. *Anthers* extrorse. *Ovary* superior, 6-celled, two only being fruitful. *Style* long. *Stigma* obtuse. *Fruit* hard, fleshy, 6-celled, the fertile cells containing each 1 oily *seed.*—*W. J. Hooker, London Journal of Botany*, 2d series, vi. p. 464, pl. 16.

The trunk of the tree abounds in milky juice. The Malays obtain it by felling the tree, stripping off the bark, and collecting the exuded juice in plantain leaves or cocoa-nut shells. Owing to this wasteful mode of obtaining the juice, the tree has already been exterminated in Singapore. The juice concretes rapidly on exposure to the air to a tough insoluble solid, of pale brown colour, which in mass constitutes gutta-percha. It is imported in blocks, each weighing about 5 pounds. It is purified from accidental impurities by softening in hot water, and separation into shreds by machinery. The floating shreds are collected, and kneaded together by machinery to separate any water retained in interstices.

1. **Gutta-Percha**, *P.B.* *Gutta-Percha.*

The concrete juice of the plant above described.

Characters and Constituents.—In tough, inelastic, flexible pieces of a light-brown or chocolate colour, of sp. gr. ·979; insoluble in water, alcohol, solutions of the alkalies, dilute acids, vegetable tar, or the fixed oils; soluble in the volatile oils, carbon disulphide, æther, benzol, and chloroform. With the latter it forms a more or less turbid solution. Above 113° it softens, and at 212° may be moulded like wax, and when its surfaces are dried it is very adhesive; it becomes negatively electric when rubbed, and when dry is an insulator of electricity. When strongly heated it is decomposed, yielding fluid hydrocarbons isomeric with oil of turpentine. It is composed of from 72 to 82 per cent. of *pure gutta* $C_{20}H_{32}$ a milk white solid, fusible at 302°, soluble in æther, chloroform, and benzol, but insoluble in alcohol. The remainder is composed of two resins—*white resin* $C_{20}H_{32}O_2$, which is deposited from hot alcohol in pearly plates, and *yellow resin* $C_{20}H_{32}O$, which is amorphous. On exposure to light and air, the gutta is slowly converted into these resins, and loses its plastic character. It may, however, be preserved under water or in the dark without change for an indefinite period.

Uses.—Gutta-percha is much used for waterproofing. It is extremely useful to the surgeon, as sheets of it softened in hot water and applied to a limb, form a perfect cast, and in a few minutes harden into a perfectly fitting splint. In the same manner it is employed by the dentist for stopping decayed teeth, the fragment of gutta-percha being softened, and at the same time dried above the flame of a spirit-lamp. The following solution of it applied to the skin forms an adhesive and protecting film:—

2. Liquor Gutta-percha, *P.B.* *Solution of Gutta-percha.*

Preparation.—Add 1 ounce of *gutta-percha* in thin slices to 6 fluid ounces of *chloroform* in a stoppered bottle, and shake them together frequently until solution has been effected. Then add 1 ounce of *carbonate of lead*, previously mixed with 2 fluid ounces of chloroform, and having several times shaken the whole together, set the mixture aside, and let it remain at rest until the insoluble matter has subsided. Then decant the clear liquid, and keep it in a well-stoppered bottle.

The carbonate of lead combines with a little dark matter insoluble in the chloroform, and carries it to the bottom of the amber-coloured solution.

Uses.—This solution may be brushed over any surface which it is desired to protect from exposure, or from irritating or contagious discharges. It may also be used for waterproofing. It is employed in the preparation of Charta sinapis.

SIMARUBACEÆ, *Lindl.* The Quassia Family.

Rutal exogens with a few seeded finally apocarpous fruit, whose pericarp does not laminate, a dry inconspicuous torus, exalbuminous seeds, and alternate leaves without stipules (Lindley). The only representative of the order growing in this country is the handsome ailanto tree (*Ailantus glandulosa*).

SIMARUBA AMARA, *Aublet.* The Mountain Damson.

This is a native of the mountainous regions of Guiana, Cayenne, and Jamaica. Its shining black drupes suggested the popular name.

Characters.—A *tree*, 50 feet high, with long horizontally spreading roots. The bark in the young parts is smooth and grey, in the older blackish-coloured, and somewhat furrowed. *Leaves* alternate, pinnate ; leaflets alternate, ovate, very smooth and entire, firm, coriaceous, deep-green. *Petioles* sometimes 1 foot in length. *Flowers* monœcious, in loose axillary panicles. *Calyx* cup-shaped, 5-toothed. *Petals* 5, longer, twisted in æstivation. *Male* stamens 10 ; *filaments* each inserted into a hairy scale. *Female* with 10 rudimentary stamens. *Ovaries* 5, on a short disc, each with a single *ovule* suspended to the inner angle. *Styles* 5, distinct at the base, united above, and separating again into 5 stigmata. *Drupes* 5, or fewer by abortion, dark-coloured, spreading, 1-celled, 1-seeded. *Embryo* straight.—*Aubl. Guian.* 2, t. 311 and 312 ; *Nees von Esenbeck,* Ic. 382, v. fig. 54.

1. Simarubæ radicis Cortex. *Simaruba Root-bark.*

Characters and Constituents.—The *bark of the root* is sent to Europe from Jamaica. It is stripped off in pieces several feet in length, which are folded upon themselves, either flat or partially quilled, a few lines in thickness, light, tough, fibrous in structure, difficult to powder, of a pale colour, greyish throughout, with the epidermis a little warty, without odour, bitter in taste. Both water and alcohol readily take up its active principle which resembles *quassin;* the bark also contains a little *volatile oil, resin,* and *ulmin.*

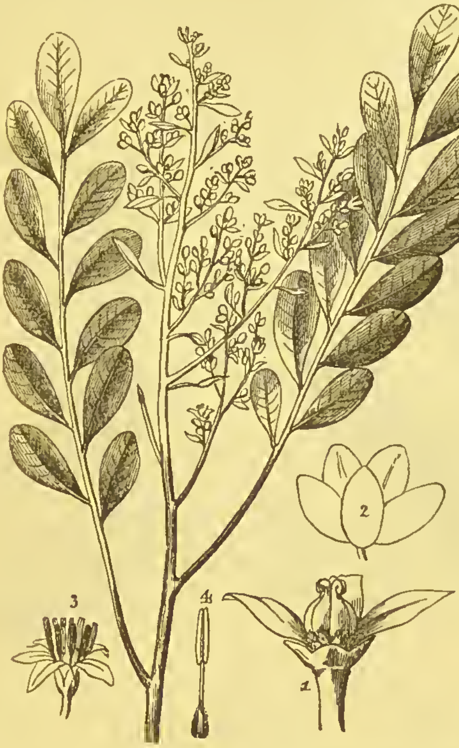


Fig. 115.—*Simaruba amara.* 1, female flower; 2, collection of drupes; 3, male flower.

Action and Uses.—Tonic and stimulant, in large doses causing vomiting, purging, and diaphoresis, and sometimes diuresis. It has been much used in dysentery, and is an useful vegetable tonic and stomachic.

Dose.—Of the powder, 15 to 30 grains. Of the infusion (½ ounce to 1 pint of boiling water), 1 to 2 ounces; as an emetic, 4 to 6 ounces.

PICRÆNA EXCELSA, *Lindl.* **The Jamaica Quassia or Bitter Wood Tree.** The *Quassia excelsa* of Swartz, *Simaruba excelsa* of Dec., and the *Picrasma excelsa* of Planchon.

This tree, which bears some resemblance to the common ash, attains a height of 50, 60, or even 100 feet in the woods of the lower mountains of Jamaica and other West India islands, where it is called *Bitter ash* and *Bitter wood.*

Characters.—*Leaves* pinnate, with an odd one. *Leaflets* opposite, 4 to 8 pairs, stalked, oblong acuminate, unequal at the base. *Flowers* small, pale yellowish-green, polygamous in loose panicles. *Sepals* 5, minute. *Petals* 5, longer than the sepals. *Stamens* 5, about as long as the sepals, rather shaggy. *Male* flowers with a rudimentary ovary. *Females, ovaries* 3, seated on a round tumid receptacle. *Style* 3-cornered, trifid; *stigmas* simple, spreading. *Drupes* 3 (but only one coming to perfection), globose, 1-celled, 2-valved, distinct from each other, and placed on a broad hemispherical receptacle. When ripe about the size of a pea, black and shining; *nut* solitary, globose, with a fragile shell.—*Steph. and Church, Med. Bot.* pl. 173.

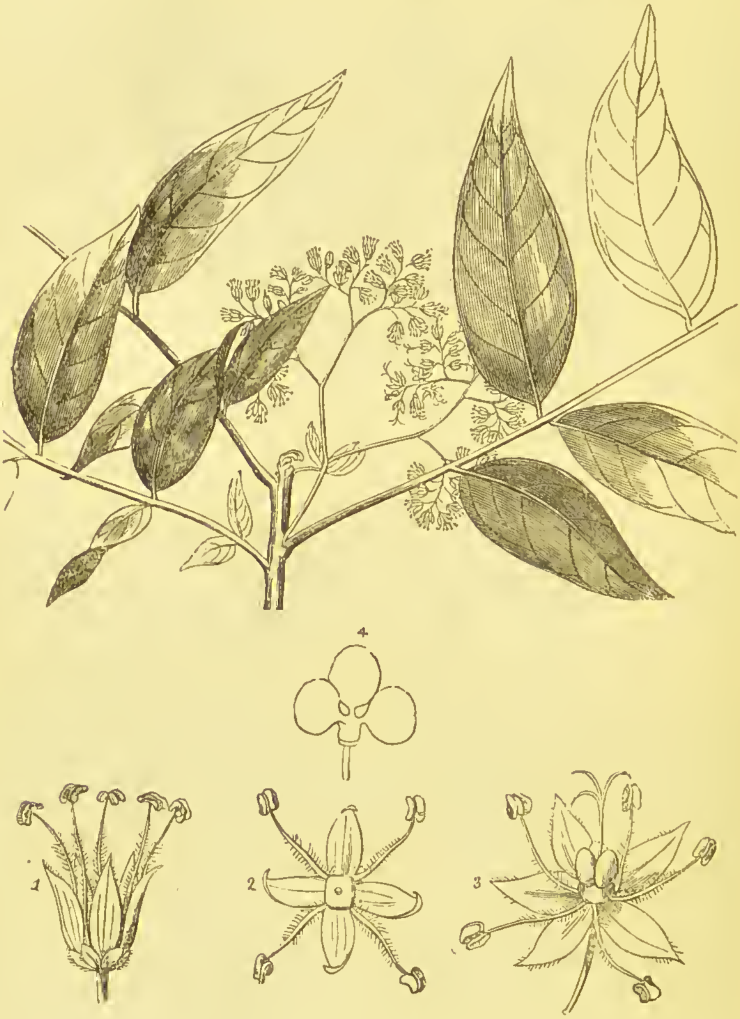


Fig. 116.—*Picræna excelsa.*
1, male flower; 2, sterile flower; 3, female flower; 4, the young drupes.

1. **Quassiæ Lignum,** *P.B. Quassia Wood.*

Derived from the plant above described, and imported from Jamaica.

Characters and Constituents.—Billets varying in size, seldom thicker than the thigh. Wood dense, tough, yellowish-white, odourless, intensely and purely bitter. Also in chips of the same. The bitter taste is due to a neutral, odourless, crystallisable principle, termed *quassin* ($C_{10}H_{12}O_3$), soluble in dilute alcohol and chloroform, from which it may be crystallised; insoluble in æther, requiring about 200 parts water for solution, and forming an insoluble compound with tannic acid. The wood yields about $\frac{1}{10}$ per cent. of this substance. It is entirely free from astringent matter.

Action and Uses.—A pure bitter tonic. In excessive doses it produces hebetude and headache, and this may be sometimes observed as a result of medicinal doses in delicate females. It is a narcotic poison to flies, and it is said also to fish. It is chiefly used as a stomachic tonic in anorexia, and as a vegetable tonic in combination with chalybeates, with which on account of the absence of tannin it may be prescribed without discoloration. *Bitter-cups* turned out of the wood are used as a ready means of furnishing the infusion. In the form of *Papier mouri* it is employed to destroy flies.

2. **Infusum Quassiæ,** *P.B. Infusion of Quassia.*

Prepared by macerating 60 grains of *quassia wood* in fine chips in 10 fluid ounces of *cold water* for half an hour, and straining.

Dose.—1 to 2 fluid ounces.

3. **Extractum Quassiæ,** *P.B. Extract of Quassia.*

Quassia wood, after maceration in enough *water* to cover it for twelve hours, is exhausted by the percolation of cold water. The liquor is then evaporated, filtered before it becomes too thick, and further evaporated by a warm water bath until the extract is of suitable consistence for forming pills.

Dose.—3 to 5 grains.

4. **Tinctura Quassiæ,** *P.B. Tincture of Quassia.*

Prepared by macerating $\frac{3}{4}$ ounce of *quassia wood* in chips in 1 pint of *proof spirit* for seven days, with occasional agitation, filtering, and washing the chips with enough proof spirit to make 1 pint of the tincture.

Dose.—$\frac{1}{2}$ to 2 fluid drachms.

QUASSIA AMARA, *Lindl.* The Surinam Quassia Tree.

This plant is the representative of a genus very closely allied to Picræna. It is an ornamental tree of small size, having elegant pinnate leaves and spike-like racemes of handsome crimson flowers. It is native of Panama, Venezuela, Guiana, and the northern parts of Brazil. It formerly supplied the quassia of English pharmacy, and it still furnishes the only kind prescribed by the German Pharmacopœia and the French Codex. The wood exactly resembles that of *Picræna excelsa* in chemical and medicinal properties. The latter is preferred in England on account of the larger size of the wood.

ZYGOPHYLLACEÆ, *R. Brown.* The Guaiacum Family.

These plants only differ from the Simarubaceæ in the following trivial characters:—Leaves opposite with conspicuous stipules, 2 or more ovules in each cell of the ovary, and a more or less syncarpous fruit. *Melianthus major* and *minor*, the Honey flower, occasionally found in our gardens, is a member of this family. The flowers of *Zygophyllum Fabago* are used as a substitute for capers. The wood of many species is remarkable for its excessive hardness.

GUAIACUM OFFICINALE, *Linn.* The Guaiacum or Lignum-vitæ Tree.

This tree is a native of the West Indies, particularly Cuba, St Domingo, and the southern part of Jamaica. It flowers in April, and the seeds are ripe in June. Guaiacum was made known in Europe by the Spaniards about the year 1508 (*Monardes*, c. xx), having been previously employed in medicine by the natives of the West Indies and of South America, where the species are indigenous, and called *Guayacan.*

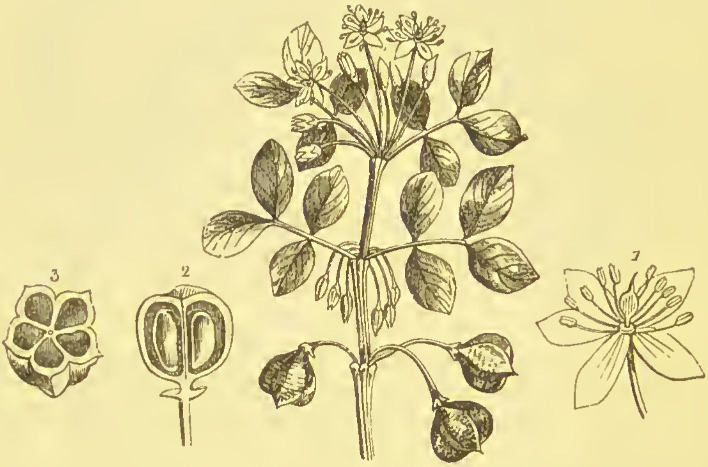


Fig. 117.—*Guaiacum officinale.* 1, flower; 2, fruit, vertical section; 3, do. horizontal.

Characters.—A large evergreen *tree,* from 40 to 60 feet in height, with deep penetrating roots, and of a dark gloomy aspect. The *wood* is hard, heavy, of a greenish colour, and remarkable for the oblique direction of its fibres. *Leaves* opposite, abruptly pinnate, with 2, sometimes 3 or 4 pairs of smooth, obovate, or oval obtuse leaflets. *Flowers* on long single-flowered peduncles, 8 or 10 generally rising together from the axils of the upper pairs of leaves. *Calyx* 5-partite, minute. *Petals* 5, oblong, spreading, light-blue. *Stamens* 10. *Style* and *stigma* simple. *Fruit* a fleshy capsule of a reddish-yellow colour, 5-angled, 5-celled, or from abortion 2-3 celled. *Seeds* solitary, pendulous, albuminous.—*Sloane, Hist.* t. 222, f. 3; *Bot. Reg.* new ser. xii. t. 91; *Steph. and Church,* plate 90.

G. sanctum, Linn., a native of Porto Rico, and *G. arboreum*, Humboldt and Bonpland, *Guayacan* of the natives of Cumana and Carthagena, are said to yield some of the guaiacum wood, or lignum-vitæ of commerce, which is also obtained from the Isthmus of Darien.

1. **Guaiaci Lignum**, *P.B.* *Guaiacum Wood.*

The wood of *G. officinale*, Linn., imported from St Domingo and Jamaica, and reduced by the turning-lathe to the form of a coarse powder or small chips. It is known in commerce by the name of *Lignum-vitæ*, and is imported in great logs, sometimes covered with a smooth grey bark. It is remarkable for its weight (sp. gr. 1·33), hardness, and toughness, and is therefore much used for pulleys, skittle balls, rulers, rollers, pestles and mortars, &c.

Characters and Constituents.—Turnings of a greenish-brown colour, becoming greener on exposure to light, and of a bright blue when moistened and exposed to the fumes of peroxyde of nitrogen. It is odourless, except when rubbed or heated, and has a faint aromatic and subacrid taste. The layers of woody fibres cross each other diagonally, and the ducts of the duramen or heartwood are filled with greenish-brown *guaiacum resin*, which forms about $\frac{1}{4}$ of the weight of the heartwood. The pale-yellowish sapwood is destitute of resin; the bark contains a different kind and a bitter acrid extract.

Action and Uses.—A mucous and cutaneous stimulant. Two or three centuries ago it was much used in the treatment of syphilis. The patient was kept in bed in a warm room and took enormous quantities of the *decoction.* Both infusion and decoction acquire the aromatic and faintly acrid taste of the resin.

An *aqueous extract* is still retained in the French Codex. According to Geiger, 1 pound of the wood yields 2 ounces of aqueous extract.

Pharmaceutical Use.—A constituent of Decoctum sarsæ compositum ($\frac{1}{4}$ ounce to 1 pint).

2. **Guaiaci resina**, *P.B.* *Guaicum Resin.*

The resin obtained from the stem by natural exudation, by incisions, or by heat. According to Browne, it often transudes spontaneously, and may thus be seen concreted on the bark at all seasons of the year, but in greater abundance when the bark has been cut and wounded. It is also obtained by heating in the fire billets of the wood which have been bored longitudinally, and receiving in a calabash the melted guaiacum at the other end. A third way of preparing it is by boiling the chips in salt and water, and skimming off the guaiacum which rises to the surface.

Characters.—In large brittle masses of a brownish or greenish-brown colour, usually associated with a little powder of a greenish tinge, fractured surface resinous, translucent at the edges. A solution in rectified spirit strikes a clear blue colour when applied to the inner surface of a paring of raw potato.

The resin may occasionally be seen in tears the size of a hazelnut; the sp. gr. is 1·2. It is easily reduced to powder, which is grey at first, but becomes green on exposure to light. It softens in the mouth; the taste, at first scarcely perceptible, is slightly bitter, but becoming acrid, it produces slight burning in the fauces. The odour is faint, increased on pounding or on heating it, when it melts and evolves a balsamic odour. It is readily soluble in alcohol, æther, chloroform, kreasote, the fixed alkalies, acetic acid, and oil of cloves. The alcoholic solution is bright, has at first a bitterish and then a pleasant taste like benzoin, followed by acridity. The fixed and volatile oils and benzol scarcely act upon it. This resin has the nature of an acid. Solutions of potash and soda dissolve it freely, as does ammoniated alcohol.

It is chiefly composed of two resinous acids, *guaiaconic* and *guaiaretic*, which are easily separated by ammonia; of about 10 per cent. of *neutral resin*, 3·5 per cent. of *gum*, and small proportions of *guaiacic acid* and *guaiacic yellow*. The two last-named bodies are crystalline. When submitted to dry distillation, guaiacum furnishes three colourless aromatic liquids, and a sublimate of pearly crystals of pyroguaiacin $C_{38}H_{44}O_6$, an odourless substance which is coloured green by ferric chloride and blue by warm sulphuric acid.

Guaiaconic acid acquires a blue colour in the presence of oxydising agents, and the development of a green or blue colour by guaiacum is a characteristic test of its presence. The resin is readily known by a little green powder attached to it, and a piece of paper soaked in a weak alcoholic solution of it assumes a beautiful blue colour when exposed to fumes of peroxyde of nitrogen. Gluten (as in the potato test above given), some varieties of albumin, globulin, saliva, nasal mucus, mucilage of gum acacia prepared with cold water, and iodides, each develop a blue colour in the presence of tincture of guaiacum, and hence this fluid has been proposed as a test for the presence of blood, but it is obviously open to innumerable fallacies. It may, however, be taken as a sure indication of the presence of guaiacum. Any oxydising substance at once determines the reaction; thus Schmidt found that a solution of hypochlorite of soda produced a green colour in a solution containing not more than $\frac{1}{320}$ part of guaiacum.

Action. Uses.—Acrid stimulant and alterative diaphoretic. In large doses, irritant. Useful in chronic rheumatism. It has been used in secondary syphilis, and in chronic skin diseases.

Dose.—20 to 30 grains in powder or bolus, or in the following mixture.

Pharmacetical Uses.—It is a constituent of the Pilula hydrargyri subchloridi co. and of the two preparations next following:—

3. Mistura Guaiaci, *P.B. Guaiacum Mixture.*

Preparation.—Triturate ½ ounce of *resin of guaiacum* in powder with ½ ounce of *sugar*, and ¼ ounce of powdered *gum acacia*, and add gradually 1 pint of *cinnamon water*.

An emulsion is formed with the aid of the sugar and gum, in which all the guaiacum is suspended.

Dose.—½ to 2 fluid ounces = 5½ to 22 grains of the resin.

4. Tinctura Guaiaci ammoniata, *P.B. Ammoniated Tincture of Guaiacum.*

Preparation.—Macerate 4 ounces of *resin of guaiacum* in fine powder in 15 fluid ounces of *aromatic spirit of ammonia* for seven days, with occasional agitation, and filter, then add sufficient aromatic spirit of ammonia to make 1 pint.

Action and Uses.—Ammoniated alcohol being an excellent solvent for guaiacum, this tincture is the best form for the exhibition of the drug.

Dose.—½ to 1 fluid drachm = 5½ to 11 grains of the resin. It may be poured on a teaspoonful or two of powdered sugar and then stirred in a wine-glassful of hot water.

XANTHOXYLACEÆ, *Nees* and *Mart.* The Xanthoxyl Family.

This small family of the Rutal alliance serves to connect the two preceding orders with the Rutaceæ proper, from which it is chiefly distinguished by a tendency to the formation of unisexual flowers. The leaves are exstipulate, and furnished with pellucid dots, the fruit 4-seeded, finally becoming apocarpous, and the pericarp separates into two layers. Many have a climbing habit, and the order includes a number of plants which, from their remarkably pungent and aromatic properties, are called "peppers" by the inhabitants of the countries where they are grown. One formed the *Faghureh* of Avicenna.

1. **Xanthoxylum fraxineum**, *Prickly Ash*, and **X. Clava**, resemble Jaborandi in their powerful sudorific and sialagogue action. The former species and *X. Carolinianum* are much used in North America as aromatic stimulant tonics.

2. **Toddalia aculeata**, *Pers.*—A prickly climbing shrub, common in Southern India, Ceylon, China, and the Mauritius, furnishes the *Lopez root*, which was formerly much employed in Europe as a remedy for diarrhœa. It is included in the Pharmacopœia for India, and is employed as an aromatic tonic and stimulant in the remittent jungle fever of India (*Royle's Illus.* 157). The bark of the root is alone used. It is covered with a velvety suberous epidermis, and is bitter, pungent, and aromatic. It contains a resin and volatile oil. It is prescribed in the form of tincture (2½ ounces of bark to 1 pint of proof spirit) and infusion (1 ounce to 10 ounces of boiling water); the dose of the former being from 1 to 3 drachms, and that of the latter 1 to 2 ounces twice or thrice a day.

2. **Ptelea trifoliata**, *The Shrub Trefoil.*—The bark of this plant is used as a tonic in remittent and intermittent fevers in North America (*Bentley*, *Pharm. Journ.* 2d ser. vol. iv.). The fruit is said to have been used with success as a substitute for hops.

RUTACEÆ, *Decand.* The Rue Family.

The common Rue may be taken as the type of this order. The leaves are exstipulate, and full of pellucid dots; the flowers are always hermaphrodite, the fruit more or less apocarpus, and the pericarp separates into two layers.

RUTA GRAVEOLENS, *Linn.* Common or Garden Rue.

This plant and *Ruta angustifolia*, both natives of the south of Europe, were much employed and highly esteemed by the ancients, as they still are by Asiatic nations.

Characters.—A small branching evergreen *under shrub,* about 2-3 feet high. *Stems* straight, slightly striated, dull-green or bluish. *Leaves* glaucous green, tripernate; leaflets thickish, dotted, oval oblong, the terminal one obovate. *Flowers* greenish-yellow, in a terminal corymb. *Calyx* small, 4-5 fid. *Petals* 4-5, yellow, oval, unguiculate, entire or denticulated; apices incurved. *Stamens* 8 or 10. *Ovary* 4-5 lobed. *Capsule* globular, warty, in 4 or 5 obtuse lobes, each separable into two valves. *Seeds* dotted. —*Woodv. Med. Bot.* pl. 37.

Every part of the rue is distinguished by a strong and repulsive odour and an acrid and bitter disagreeable taste, due to the presence of volatile oil and bitter extract. The leaves have the strongest odour when the seed-vessels are well developed but still green. A great portion of their volatile constituent is necessarily lost in drying. The unripe fruit is also used as a source of the oil, the pericarp being excavated by large oil-vesicles.

Action. Uses.—Rubefacient, stimulant, antispasmodic, emmenagogue, anthelmintic. It was supposed by the ancients to strengthen the eyes, and to be an antidote to hemlock.

Dose.—1 to 2 fluid ounces of an infusion of 1 ounce of the fresh herb in 1 pint of boiling water.

Oleum Rutæ, *P.B.* *Oil of Rue.*

The oil distilled from the fresh herb.

It is prepared in England by distilling the leaves, twigs, and seed-vessels with water. According to Lewis, the plant yields nearly three times as much oil (about ½ per cent.) after flowering, and when the seeds are nearly ripe, as before flowering.

Characters.—Pale yellow; odour that of the plant; taste bitter, acrid. According to G. Williams, it is composed chiefly of *euodic aldehyd* $C_{11}H_{22}O$, besides which there are small quantities of *lauric aldehyd* $C_{12}H_{24}O$, and a hydrocarbon isomeric with oil of turpentine and borneol. By the prolonged action of nitric acid the oil furnishes pelargonic acid $HC_9H_{17}O_2$ and rutic acid $HC_{10}H_{19}O_2$. Rutic acid crystallises in colourless needles; it has a faint goat-like odour and sour burning taste. It is but sparingly soluble in boiling water, and furnishes crystalline salts.

Action and Uses.—Applied to the skin oil of rue is rubefacient, and even vesicant. Internally it is stimulant and antispasmodic. It is useful in flatulent colic, especially of children, and in dysmenorrhœa.

Dose.—1 to 3 minims, dissolved in a few drops of rectified spirit, and mixed with a little syrup of orange peel.

GALIPEA CUSPARIA, *St Hilaire.* The Cusparia Tree.

This tree varies much in size, according to the elevation at which it grows. It is the *G. officinalis* of Hancock and the *Bonplandia trifoliata* of Willdenow. It grows freely on the mountains of San Joaquin in Venezuela, and in the districts eastward of the Caroni, and near its junction with the Oronoco, and in the tropical forests between Cumana and New Barcelona. The bark, commonly called

Angostura bark, is known in South America as *Caxarilla del Angostura* and *Quinia de Caroni.* It has been used in Spain for a century and a quarter, and was first imported into England in 1788.

Characters.—A shrub or lofty tree, *Leaves* trifoliate, on long stalks; *leaflets* large, sessile, unequal, ovate-lanceolate, acute, fragrant, with scattered glandular dots. *Flowers* racemose. *Calyx* cup-shaped, 5-fid. *Corolla* white, the 5 petals cohering below into a subangular tube, both calyx and corolla furnished externally with bundles of hairs arising from glandular elevations. *Stamens* 4–8, monadelphous,—only 2 fertile; *anthers* with 2 short appendages. *Carpels* 5; *Stigmas* 5. *Capsules* by abortion, 1 or 2. *Seeds* solitary. —*Steph. and Church, Med. Bot.* pl. 149.

1. **Cuspariæ cortex,** *P.B.* *Cusparia Bark.*

Imported from tropical South America.

Characters and Tests.—In straight pieces, rarely 6 inches long, from ½ to 1½ line in thickness, in small quilled pieces, resembling cascarilla, but not so white externally, nor presenting the transverse slits characteristic of that bark, or in slightly curved, flattish pieces, 1–2 inches wide, covered externally with a thin, soft, suberous layer, and furnished with a greyish-white mottled epidermis. The inner surface is of a cinnamon colour, and is smooth and compact. It is very compact throughout, and hard and crisp, the fractured surface being smooth, and bounded by sharp edges. A cross section examined by a lens usually exhibits numerous white points or minute lines (raphides of oxalate of lime and whitish liber fibres), and under a higher power a number of scattered cells, a little larger than those of the parenchyma, filled with yellowish oil or granules of resin. In oblique fractures the layers of pale liber fibres sometimes give an undulating or feathery appearance to the broken edge. The taste is bitterish and nauseously aromatic. The inner surface, touched with nitric acid, does not become blood-red.

This last test is intended to detect strychnia bark, which was once shipped from India as cusparia bark. There is little danger of the mistake being repeated; but if there should be any doubt as to the identity of the bark, it will be removed by chewing a fragment, when cusparia bark will be recognised by a disagreeably aromatic flavour, and that of strychnia by its pure and intensely bitter taste. This test is more decisive than the action of nitric acid, which gives a deep brownish-red with cusparia bark.

Constituents.—Cusparia bark yields ¾ per cent. of a pale-yellow *volatile oil*, having the heavy aroma of the bark, about 1½ per cent. of *cusparin*, a neutral substance, crystallising, according to Saladin, in tetrahedra, and soluble in alcohol, but sparingly so in water. It may be obtained by spontaneous evaporation of the tincture; and *two resins*, the one hard and bitter, the other soft and acrid. The bark is free from tannin, but gives a copious russet precipitate with ferric chloride.

Action and Uses.—A stimulant aromatic tonic and febrifuge. Its stimulant properties are due to the oil and resin, its tonic to cusparin. In excessive doses it becomes an irritant to the mucous membrane, producing nausea and purging; but in proper doses it is beneficial in atonic dyspepsia and in chronic diarrhœa and dysentery. As an aromatic tonic it closely resembles cascarilla, and in its febrifuge action it approaches cinchona. As it is free from astringency. it is sometimes more suitable than cinchona. It has been employed with success in intermittent and remittent fevers.

Dose.—10 to 40 grains of the powdered bark may be given; but the infusion or a tincture is a more suitable form.

2. **Infusum Cuspariæ,** *P.B.* *Infusion of Cusparia.*

Prepared by infusing ½ ounce of the bark in coarse powder in 10 fluid ounces of water at 120° for two hours, and straining.

Dose.—1 to 2 fluid ounces.

3. **Tinctura Cuspariæ.** *Tincture of Cusparia.*

Prepared by macerating 2½ ounces of the coarsely powdered bark in 15 ounces of spirit, and obtaining 1 pint of the tincture by the process prescribed for Tinctura aconiti.

Dose.—1 to 4 fluid drachms.

PILOCARPUS PINNATIFOLIUS, *Lemaire.* **Jaborandi.**

The leaves of this and other species of Pilocarpus have been recently introduced to the notice of the profession in Europe by Dr Coutinho of Pernambuco. The species are natives of Brazil, and the term Jaborandi or Jamborandi is applied to the whole of these aromatic sialagogue and diaphoretic plants. A description of several of the species may be found in Martius's *Flora Braziliensis*, fascisc. 65; that of *P. pinnatifolius* by Lemaire in the *Le Jardin fleuriste*, tab. 263. The genus is referred to the Dictamneæ division of the Rutaceæ, and in the large pinnate aromatic dotted leaves, and characteristic fruit, the species completely resemble the garden Fraxinella. The accompanying figure is drawn by the aid of materials kindly given to me by Mr Martindale. As the flower-stalk and fruit completely resembled that of a species (*P. parviflorus*) described in the *Acta Nova Physicico-Med.* vol. ii. pl. xxx. by Nees and Martius, I have introduced it with Vahl's diagnostic figures of the genus.

Characters.—A shrub, bark light-grey with irregular linear elevations presenting paler circular dots. *Leaves* 12 to 18 inches long; imparipinnate; *leaflets* 1 to 4 pairs, shortly petiolate, 4 to 6 inches long, oblong-lanceolate, emarginate, smooth or only slightly tomentose about the origin of the veins, full of pellucid dots. *Flowers* in long spike-like racemes, often longer than the leaves, axillary and terminal. *Calyx* very short, 4–5 fid. *Petals* 5, equal, spreading with a valvate or only slightly imbricate æstivation. *Stamens* shorter than the petals, inserted under an annular disc. *Ovary* half included within the disc; *style* short, simple. *Carpels* 5, or by abortion 4, connate at the base, but ultimately becoming distinct, arcuato-sulcate with a loculicidal dehiscence, the endocarp becoming free, and forming a stiff elastic bilobed lamina. *Seeds* black, angular, often solitary.

The leaves and bark of Jaborandi are slightly aromatic, and very acrid, producing when chewed a fine prickling warming glow in the mouth, exactly like that experienced on chewing pyrethrum root. The bark is rather more pungent than the leaves.

Characters and Constituents.—Leaves from 2 to 6 inches long, and ¾ to 2 inches broad, leathery, yellowish or greenish-brown. The apex rounded, and slightly bilobed the mid-rib terminating in a rounded notch; margins slightly recurved; veins distinctly marked, and terminating in an undulating line just within the margin. Viewed by a strong light the parenchyma is seen to be everywhere interrupted by minute pellucid dot-like glands. The taste and odour are aromatic, resembling that of cusparia, but without bitterness, and it soon produces a sensation of tingling in the mouth, accompanied by an increase of saliva.

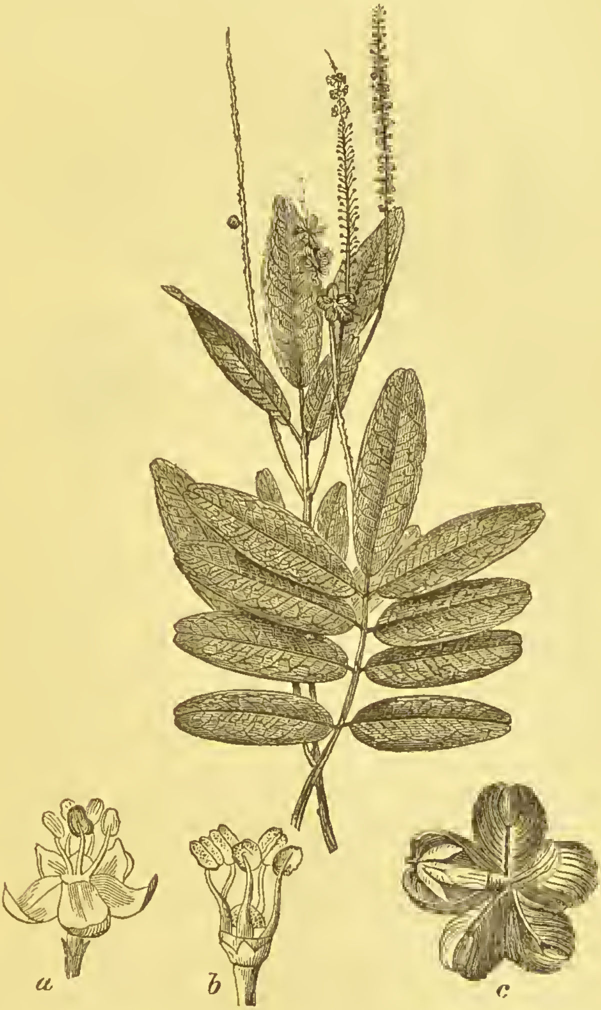


Fig. 118.—*Pilocarpus pinnatifolius.*
a, flower; *b*, flower with the petals removed; *c*, carpels.

The leaves contain an *acrid resin*, a *volatile oil*, *tannic acid*, and alkaloid termed *pilocarpia*. The resin is soluble in æther. *Pilocarpia* or *pilocarpine* is the principle to which the sialagogue and sudorific properties of the plant are due. It appears to have been almost simultaneously isolated by MM. Hardy and Rochefontaine, and Mr A. W. Gerrard. It is a colourless crystalline substance, soluble in water, alcohol, and in chloroform, and forming crystalline salts with the acids. The hydrochlorate is deliquescent, and soluble in alcohol. The nitrate is permanent, and insoluble in alcohol. Mr Gerrard obtained it by the following process:—

Prepare a soft extract of either the leaf or bark with proof spirit. Digest this with water, filter and wash. Evaporate the filtrate to a soft extract, cautiously add ammonia in slight excess, shake with chloroform, separate the latter, and evaporate; the residue is impure pilocarpia, which may be purified by re-solution in acidulated water, and recrystallisation from chloroform.

Action and Uses.—The action of Jaborandi, like that of certain of the Xanthoxylaceæ (p. 679), is sialagogue and sudorific. In large doses it causes nausea, and occasionally emesis. The observations of Grebler, Vulpian, Féréol, Rabuteau, Ringer, Gould, Martindale, and indeed of all who have used the plant, concur in proving that its action is very direct and uniform. An infusion of 30 to 60 grains causes, within ten or fifteen minutes, salivation and sweating, which usually become profuse, and continue about an hour. The pulse is simultaneously accelerated and relaxed, and the temperature slightly diminished. In some cases the salivation is excessive, and a pint or more of saliva may be collected within half an hour. When emesis occurs it is often followed by considerable prostration. These symptoms have sometimes been reproduced twice a week for six weeks without injurious results; but the great hyperæmia of the salivary glands, which occurs during the action of the drug, appears to have resulted in inflammatory action and abscess in one or two cases. Locally applied, a solution of pilocarpia causes contraction of the pupil. According to Vulpian, the effects of Jaborandi are due to a direct stimulation of the vaso-dilator nerves of the salivary glands and the skin, an action directly antagonistic to that of atropia, which Kenchel asserts paralyses these same nerves.

The potent effects of Jaborandi, above described, are well known to the natives of the country where the species grow, but it does not appear that they have applied them to any very important practical use. Nor are the reports of those who have employed the drug in Europe very encouraging. Diseases associated with or dependent upon imperfect action of the salivary glands and the skin are those which we may expect to be benefited by its use.

Dose.—½ to 1 ounce of the infusion (1 ounce of the leaves to 10 ounces of boiling water); of pilocarpia, ½ grain by the mouth, or ⅓ grain subcutaneously.

BAROSMA BETULINA, CRENULATA, and SERRATIFOLIA. Buchu.

These are shrubby plants, native of the Cape of Good Hope. They derive their generic name from their heavy aromatic odour (*βαρὺς ὀσμή*) due to a volatile oil, stored, as in the rest of the Rutaceæ, in receptacles in the epidermis.

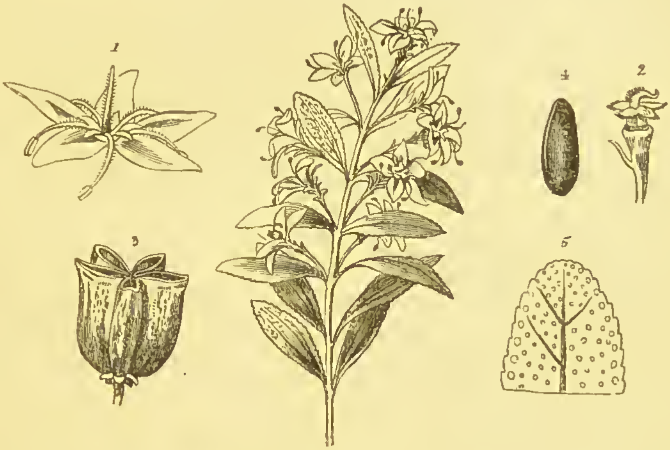


Fig. 119.—*Barosma betulina.*
1, flower; 2, stigma; 3, fruit; 4, seed; 5, portion of leaf showing the glandular dots.

Common Characters.—*Leaves* opposite, small, simple, coriaceous, dotted with pellucid glands (5). *Flowers* solitary on axillary or terminal peduncles (fig. 119). *Calyx* 5 cleft. *Petals* 5. *Stamens* 10, 5 abortive, petaloid filaments of the fertile ones becoming recurved. *Carpels* 5, united into a 5-lobed ovary. *Style* as long as the petals; *stigma* 5-lobed. *Fruit* composed of 5 follicles adherent at the axis, and dehiscing at the summit (3); *seeds* oblong, smooth (4).

α B. BETULINA, Bartling (*Diosma crenata,* Dec.)—*Leaves* obovate, recurved at the apex, serrated, with marginal glands. *Flowers* pink.—*Berg. u. Schmidt, Off. Gewächse*, plate 1, f; *Loddige's Bot. Cab.* i. 404.

β B. CRENULATA, Hooker (*Diosma crenulata,* Linn.; *Dodorata,* Dec.)—*Leaves* ovate lanceolate, obtuse, crenate. *Pedicels* with two bracts immediately under the flower.—*Bot. Mag.* vol. lxii. pl. 3413.

γ B. SERRATIFOLIA, Willd. (*Diosma serratifolia,* Dec.)—*Leaves* linear-lanceolate, acutely serrulate. *Flowers* white, pedicels with two bracts above the middle.—*Bot. Mag.* vol. xiii. pl. 456; and *Bot. Cab.* t. 378.

1. **Buchu folia,** *P.B.* *Buchu Leaves.*

Derived from the species above described, imported from the Cape of Good Hope.

The leaves of several plants, called *Buchu, Bucku,* or *Bookoo,* were found by Burchell, the African traveller, to be employed by the Hottentots as a vulnerary, and in the treatment of diseases of the urinary organs. They were introduced into medical practice in this country in 1821.

Characters and Constituents.—Smooth, shining, and leathery, of a light yellowish or greyish-green colour, with pellucid dots at the indentations and apex; having a powerful odour, and a warm camphoraceous or mint-like taste. Of the three species, those of α are about $\frac{3}{4}$ inch long, coriaceous, obovate, with a recurved truncated apex and sharp stiff spreading teeth; those of β, about 1 inch long, oval-lanceolate, obtuse, minutely crenated, 5-nerved; and those of γ from 1 to $1\frac{1}{2}$ inch long, linear-lanceolate, tapering at each end, sharply and finely serrated, 3-nerved.

The leaves yield by distillation $1\frac{1}{2}$ per cent. of *volatile oil* of a peppermint odour, which at a low temperature deposits a little crystalline *barosma camphor*, which has also a pure mint odour. The leaves also contain a little mucilage, afforded, according to Flückiger, by a colourless layer of cells underneath the epidermis. Perchloride of iron gives a dingy brownish-green colour to the aqueous infusion. Acetates of lead and copper throw down a yellow precipitate.

Substitutes.—Hanbury (*op. cit.*) states that the leaves of the rutaceous plant *Empleurum serrulatum*, Ait., have been frequently imported of late for buchu. They resemble those of *B. serratifolia*, but are easily distinguished, being narrower, of a bitter taste and different odour, and terminating in an *acute* point *without a gland.*

Action and Uses.—An aromatic stimulant, both topically and remotely; thus it directly stimulates the stomach, and produces diaphoresis and diuresis, apparently as a consequence of the elimination of the volatile oil by the skin and kidneys. It appears, however, that the oil, like camphor and turpentine, undergoes decomposition in its way out of the system, as no trace of it has been detected in the secretions. It is beneficially employed as a stomachic stimulant in atonic dyspepsia, and in chronic irritation of the genito-urinary organs, as in cystitis and gleet. Its influence in diminishing the irritability associated with lithiasis has led to the idea that it checks the formation of lithic acid, but the benefit must be attributed rather to its gentle stimulant action on the mucous membrane, whereby a more healthy condition of the secretion, and consequent diminution of irritability, would result; and to its diuretic effects which are attended by dilution and increased solvent action of the urine.

It may be given in either of the following forms:—

2. **Infusum Buchu,** *P.B.* *Infusion of Buchu.*

Infuse $\frac{1}{2}$ ounce of *buchu leaves bruised* in 10 ounces of *boiling water*, in a covered vessel, for an hour, and strain.

It is necessary to bruise the leaves in order to rupture the little cells in which the oil is stored.

Dose.—1 to 4 ounces.

3. **Tinctura Buchu,** *P.B.* *Tincture of Buchu.*

Macerate $2\frac{1}{2}$ ounces of *buchu leaves* in coarse powder for forty-eight hours in 15 fluid ounces of *proof spirit*, with occasional agitation, then transfer to a percolator, and proceed as with Tinctura aconiti in order to obtain 1 pint of the tincture.

Dose.—1 to 2 fluid drachms.

AURANTIACEÆ, *Correa.* The Orange Family.

The trees or shrubs which compose this order are very closely allied to the Rutaceæ, from which they are distinguished merely by a syncarpous, juicy, indehiscent fruit. Like the rueworts the leaves, fruit, and bark are pervaded by minute receptacles of volatile oil. These attain their maximum development in the rind of the orange. The following genus may be taken as the type of the order:—

CITRUS VULGARIS, *Risso.* The Orange.

The orange, like the lemon, is a native of India, being found in the forests on the borders of Silhet, and on the Neilgherries. The Sanscrit *Nagrunga* and the Arabic *Narung* are no doubt the European names of *Naranja* (Spanish), *Arancia* (Italian), whence we have *Aurantium* and *Orange.* The orange is not mentioned either by the ancients or the Arabian medical authors. It is supposed to have been introduced into Europe after the middle ages.

Of this plant, the *C. vulgaris* of Risso, there are two varieties—the *bitter*, or Seville orange tree (*α bigaradia*), and the *sweet*, or Portugal orange tree (*β Aurantium*). The former is supposed to have been introduced, through Syria and Africa, into Europe by the Arabs. There is reason for assuming that the Moors introduced the bitter variety into Spain, because all the old-established groves of this country are composed of bitter orange trees like those of Seville, which are known to have been planted by the Moors. The sweet orange was introduced into Europe in the 14th century by the Portuguese.

Characters.—VAR. *α* BIGARADIA.—A small *tree* or arborescent shrub about 16 feet high, the branches with axillary spines. *Leaves* simple, elliptical, acuminate, finely toothed, articulated to a winged petiole. *Flowers* large, white, fragrant. *Calyx* urceolate, 3–5 cleft. *Petals* 5, attached by a broad base to the outside of an hypogynous disc. *Stamens* about 20; filaments flattened. *Style* solitary. *Stigma* expanded, indistinctly lobed. *Fruit* (hesperidium) composed of about 18 carpels; from 7–12 celled, pulpy, covered with a thick, rich orange-coloured, puckered rind, full of spherical receptacles of volatile oil, each cell containing from 4 to 8 *seeds*, and numerous little bags of very acid bitter pulp. *Seeds* exalbuminous, sometimes containing more than one embryo.—*Risso, Histoire Naturelle des Orangers*, tab. 30. VAR. *β* AURANTIUM.—*Tree* 20 feet high, destitute of spines. *Petiole* less broadly winged. *Fruit* larger, paler, often yellow, nearly smooth, rind thin, pulp sweetly acidulous. The fruit is less aromatic, and the flowers are not so strongly fragrant as those of the bitter orange.—*Risso*, tab. 3 and 4.

The orange is cultivated in the south of Europe and in the Azores, whence the fruit is largely imported into this country. The flowers and rind of the fruit of the bitter orange are alone prescribed in the Pharmacopœia. The ripe fruit of the sweet orange is esteemed for its agreeable and refreshing juice, which is gratefully refrigerant when there is thirst and pyrexia. The small unripe fruits which fall early, when dried, form the Curaçao oranges, so called because they are used for flavouring the liqueur curaçao. The oil distilled from these immature fruits, as well as those of the bitter orange, is called *essence of petit grain.* It is largely used in the preparation of *Eau de Cologne.* The smaller of these unripe fruits are dried, smoothed, and used, under the name of *Aurantii baccæ*, for issues. The rind of the sweet orange is often substituted for that of the bitter.

1. **Aurantii cortex,** *P.B. Bitter Orange Peel.*

Both the fresh and dried outer part of the rind of the bitter orange. From the ripe fruit, imported from the south of Europe.

Characters and Constituents.—Thin, of a dark orange colour, nearly free from the white inner part of the rind, having an aromatic bitter taste and fragrant odour.

Orange peel contains a bitter principle, *hesperidin* or *aurantiin*, a glucoside which is probably identical with limonin (see p. 691); a trace of tannic acid, and a *volatile oil.* This latter, which is obtained by the *écuelle à piquer*-process, or by the sponge (see p. 692), appears to have the same composition as Oleum neroli, which it resembles in odour. It is obtained from both varieties of orange, and is distinguished as *Essence de Bigarade* and *Essence de Portugal.* The former is most esteemed. It is chiefly used in flavouring *curaçao*, and as a perfume, especially in the manufacture of *Eau de Cologne.*

Action and Uses.—A bitter aromatic tonic and stimulant. It is used as a flavour and as a stomachic tonic, in the forms given below, and in the following preparations:—Infusum gentianæ compositum, Mistura gentianæ, and Tinctura gentianæ composita.

2. **Infusum Aurantii,** *P.B. Infusion of Orange Peel.*

Prepared by infusing ½ ounce of *dried bitter orange peel*, cut small, with 10 ounces of *boiling water* in a covered vessel for fifteen minutes, and straining.

Dose.—1 to 2 fluid ounces.

3. **Infusum Aurantii compositum,** *P.B. Compound Infusion of Orange Peel.*

Prepared by infusing ¼ ounce of *dried bitter orange peel*, cut small; 60 grains of *fresh lemon peel*, cut small; and 30 grains of *cloves* bruised in 10 fluid ounces of *boiling water* in a covered vessel for a quarter of an hour, and straining.

Dose.—1 to 2 fluid ounces.

4. **Tinctura Aurantii,** *P.B. Tincture of Orange Peel.*

Preparation.—Macerate 2 ounces of *dried bitter orange peel*, cut small and bruised, in 1 pint of *proof spirit* for seven days in a closed vessel, with occasional agitation, then strain, press, and filter, and add enough proof spirit to measure a pint.

Action and Use.—A stomachic stimulant and useful means of readily imparting the flavour of orange to mixtures.

Pharmaceutical Uses.—In the preparation of Mistura ferri aromatica, Tinctura quiniæ, and Syrupus aurantii.

5. **Tinctura Aurantii recentis.** *Tincture of Fresh Orange Peel.*

Preparation.—Macerate 6 ounces of the coloured part of the *rind of the ripe fruit of the bitter orange*, peeled off in thin slices, in a pint of *rectified spirit*, for a week, with frequent agitation. Then pour off the liquid, press the dregs, mix the liquid products, and filter; finally add sufficient spirit to make 1 pint.

This addition to the Pharmacopœia is intended, we assume, to supply the place of the preceding preparation.

6. **Syrupus Aurantii,** *P.B.* *Syrup of Orange Peel.*

Prepared by mixing 1 fluid ounce of *tincture of orange peel* with 7 fluid ounces of *syrup.*

A pleasant menstruum for the exhibition of mineral acids and insoluble powders. It is used in the preparation of Confectio sulphuris.

7. **Vinum Aurantii,** *P.B.* *Orange Wine.*

Wine made in Britain by the fermentation of a saccharine solution, to which the fresh peel of the bitter orange has been added.

Characters and Tests.—A golden, sherry colour, and a taste and aroma derived from the bitter orange peel. It contains 12 per cent. of alcohol, and is but slightly acid to test paper.

Pharmaceutical Uses.—In the preparation of Vinum ferri citratis and Vinum quiniæ.

8. **Aqua Aurantii floris,** *P.B.* *Orange-Flower Water.*

The distilled water of the fresh flowers of the bitter orange tree (*Citrus bigaradia*) and of the sweet orange tree (*C. Aurantium*), prepared mostly in France.

Characters and Tests.—Nearly colourless, fragrant, not coloured by sulphuretted hydrogen. When imported in leaden vessels, or copper ones soldered with lead, the water contains an appreciable quantity of the latter metal, due to the solvent action of pure water on lead (see p. 239).

It is a saturated aqueous solution of the *volatile oil* (see below).

Action and Use.—Orange-flower water is considered in France to be possessed of anodyne and antispasmodic properties, and is in constant use in doses of 1 to 2 fluid ounces in nervous and hysterical cases. It is used in the following preparation:—

9. **Syrupus Aurantii floris,** *P.B.* *Syrup of Orange Flower.*

Preparation.—Dissolve 3 pounds of *refined sugar* in 16 ounces or a sufficiency of water by means of heat; strain, and when nearly cold add 8 fluid ounces of *orange-flower water*, with a sufficiency of water, if necessary, to make the product 4½ pounds. The specific gravity should be 1·33.

Use.—An agreeable vehicle for certain medicines, such as chalybeates.

10. **Aurantii Oleum florum.** *Oil of Orange Flowers. Oil of Neroli.* F. *Essence de Néroli.* G. *Neroliöl.*

The oil secreted in the petals of both kinds of orange is much more delicate and fragrant than that stored in the leaves and rind of the fruit. It is prepared (principally at Grasse, Cannes, and Nice) by distilling the fresh flowers with water in copper stills. The oil as it accumulates is skimmed from the surface of the water. That obtained from the flowers of the bitter orange is the finer. Flückiger and Hanbury are informed on good authority that the oil of neroli commonly sold contains ⅛ of essence of petit grain (oil obtained by distillation of the leaves), ⅛ of essence of bergamot, and ⅘ of oil of neroli. They give the following as the characters of the pure Bigaradia Neroli—"Of a brownish hue, most fragrant odour, bitterish aromatic taste, neutral to test paper, sp. gr. at 51°·8 0·889. When a little alcohol is poured on its surface, and caused to gently undulate, it displays a bright violet fluorescence, distinct from the fluorescence of solution of quinine. Shaken with a saturated solution of bisulphite of sodium, it assumes an intense and permanent crimson hue" (*Pharmacographia*, p. 113).

Action. Uses.—The essential oil is stimulant and antispasmodic. If pure, it may be employed for making orange-flower water. It is used for giving an agreeable perfume to unguents and liniments.

CITRUS LIMONUM, *Decand.* The Lemon.

F. *Citron* or *Limon.* G. *Citrone.*

Lemons were unknown both to the ancients and to the Arabs, though noted in Persian works on Materia Medica by the names *Leemoo* and *Neemboo*, and stated to be natives of India, where they are indigenous, and known by nearly the same names. The author has found the tree apparently wild in the forests at the foot of the Himalayan mountains. The annexed figure (120) is from one of these plants. Limes are produced by a distinct species, *Citrus acida.*

Characters.—A *shrub* from 10 to 15 feet in height, much branched, with stiff awl-shaped thorns. *Leaves* oval, or oblong-oval; margin serrulate, or slightly toothed. *Petioles* with a narrow leafy border, or simply margined. *Flowers* with 5, sometimes 4 petals. *Stamens* 20 to 30, in 4 or 5 bundles. *Fruit* of a light-yellow colour when quite ripe, ovoid in shape, with a more or less nipple-like knob at the apex. *Rind* thin, with numerous vesicles of oil, adhering closely to the pulp, which is very acid.—*Steph. and Church, Med. Bot.* pl. 92.

The fruit of the lemon yields essential oil, and lemon juice which is the source of citric acid.

1. **Limonis cortex,** *P.B.* *Lemon Peel.*

The outer part of the rind of the fresh fruit, imported from Southern Europe.

Characters and Constituents.—Finely tuberculated, of a bright pale-yellow colour, fragrant odour, and acid and fragrant bitter taste. Internally white. The rind contains a *bitter principle* common to the rest of the genus, and *volatile oil* (see below). The former is called *hesperidin* or *aurantiin.* *Limonin*, obtained by Dr Bernays from the seed, is probably identical. The presence of hesperidin in the white portion of the rind is indicated by the production of a yellow colour by moistening it with ammonia.

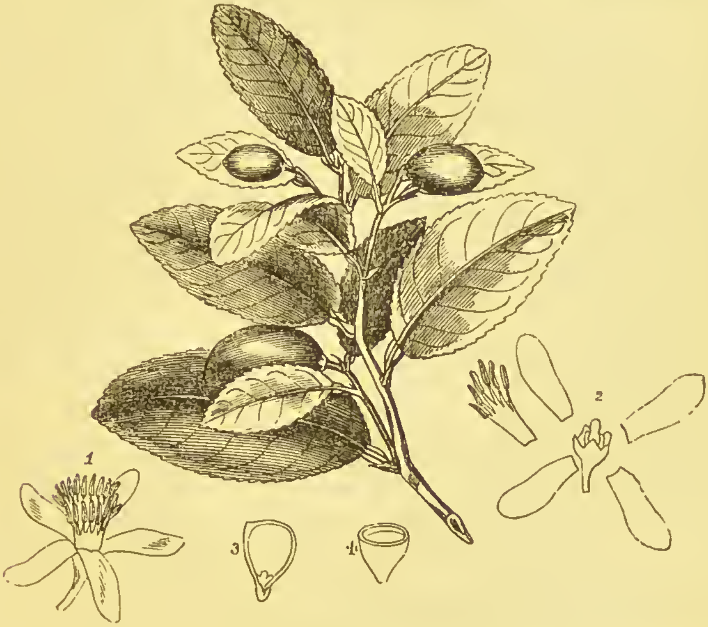


Fig. 120.—*Citrus Limonum.* 1, flower; 2, separate portions of ditto; 3, seed in vertical, and 4, in transverse sections.

Action and Uses.—Aromatic and tonic, like that of orange. It is a constituent of Infusum aurantii compositum, I. gentianæ compositum, and Syrupus limonis, and is employed in the preparation of the following:—

2. **Oleum Limonis,** *P.B.* *Oil of Lemon.* *Essence of Lemon.* F. *Essence de Citron.* G. *Citronenöl.*

The oil expressed or distilled from fresh lemon peel, imported chiefly from Sicily. It is chiefly produced in Sicily, on the Calabrian coast at Reggio, and at Mentone and Nice. Two processes are employed—viz., expression and scarification. In the first process the oil vesicles are ruptured by squeezing the rind in the palm of the hand against a flat piece of sponge, which absorbs the oil. The sponge is wrung out from time to time, and the oil is decanted from a little of the watery juice which is separated in the process.

The second process is equally simple. The workman takes a lemon in the hand, and rotates it over the points of brass-pins about half an inch long, and fixed in a saucer-like vessel, which is prolonged at the centre into a depending tube, in which the oil accumulates. The vessel is called an écuelle à piquer (Hanbury, *Pharmacographia*, p. 107).

Characters.—Pale-yellow, odour sweetly fragrant, taste aromatic, warm, and bitter; sp. gr. about 0·85; it is isomeric with oils of orange, bergamot, and turpentine, which are represented by the formula $C_{10}H_{16}$. All furnish solid crystalline products when saturated with hydrochloric acid gas; but that furnished by oil of lemon contains two molecules of hydrochloric acid $C_{10}H_{16}2HCl$; whereas the oil of turpentine compound, obtained by the same means, contains only one (see Artificial Camphor, p. 406). After long keeping, oil of lemon deposits a little crystalline fat.

Adulterations.—Like oil of bergamot, that of lemon is rarely or never pure. It is commonly diluted with an inferior oil prepared by distillation of the rasped peel, or largely mixed with oil of turpentine. The presence of the former diminishes the fragrance, and the latter confers a turpentine odour. The druggist should prepare a few drops of the oil by the second of the processes given above, in order to have a standard of comparison.

Pharmaceutical Uses.—In the preparation of Linimentum potassii iodidi cum sapone, and Spiritus ammoniæ aromaticus.

3. **Tinctura Limonis**, *P.B. Tincture of Lemon Peel.*

Preparation.—Macerate for seven days in a closed vessel 2½ ounces of *fresh lemon peel* sliced thin, with 1 pint of *proof spirit*, agitating occasionally. Strain, press, and filter; then add sufficient proof spirit to make 1 pint.

Dose.—½ to 2 fluid drachms.

4. **Limonis succus**, *P.B. Lemon Juice.*

The freshly expressed juice of the ripe fruit of *Citrus Limonum*, Decand.

Before the fruit is subjected to pressure, it should be deprived of both peel and seeds. It is necessary, moreover, that the fruit be fresh, as well as ripe; for Stoddart has shown that the citric acid is gradually converted into glucose and carbonic acid if the fruit be kept from February to July.

Characters.—A slightly turbid liquor of a yellowish tinge, a sharp acid taste, and the grateful odour of the lemon. Average sp. gr. 1·039; average quantity of citric acid in the fluid ounce 32½ grains, or about 7 per cent.

The juice also contains about 4 per cent. of sugar and gum, 2¼ per cent. of salts, chiefly of potash, and a little phosphoric acid.

It is apt to become mouldy and to ferment slightly; but this may be prevented by careful bottling and preservation in a cold place. The British Navy is supplied with it from Sicily, preserved by the addition of $\frac{1}{10}$ of strong brandy. Druggists preserve it by the addition of alcohol; a little mucilage separates, and this is removed by filtration.

Action and Uses.—Refrigerant, antalkaline, and antiscorbutic. Diluted with water, it forms a refreshing drink in hot climates. In the febrile state it is generally given as a refrigerant and to allay thirst, in the form of lemonade or added to barley or rice water. It has been recommended in rheumatism; but its efficacy in this disease is doubtful, and rests on no scientific data. In my opinion the use of the free acid in this disease is likely to prove injurious, unless it be combined with an alkali, in which case it is eliminated as carbonate, rendering the urine alkaline. As an antacid it is constantly employed, neutralised with potash or soda, and taken in the form of effervescent draughts. As an antiscorbutic, lemon juice is regularly served out as a prophylactic to the members of the navy and merchant service, each sailor receiving from 1 to 2 ounces daily during a long voyage, and during the prevalence of scurvy from 4 to 6 ounces. If the fresh juice cannot be obtained, a solution of citric acid, as follows, may be substituted :—

An *artificial juice* may be prepared by the solution of 1½ ounce of citric acid in a pint of water, and the addition of 3 or four drops of oil of lemon and ¾ ounce of sugar.

5. **Syrupus Limonis,** *P.B.* *Syrup of Lemons.*

Preparation.—Heat 1 pint of *lemon juice* to the boiling point, place it in a covered vessel with 2 ounces of fresh *lemon peel*, and let them stand until cold; then filter and dissolve 2¼ pounds of sugar in the filtrate with a gentle heat. The product should weigh 3½ pounds, and should have the sp. gr. 1·34.

A pleasant adjunct to effervescent draughts, &c.

Dose.—1 fluid drachm.

6. **Lemonade** is prepared by macerating 2 lemons sliced in 1 pint of boiling water and sweetening with 2 ounces of sugar.

Effervescing Lemonade.—This is prepared by adding 2 fluid ounces of syrup of lemons to 1 pint of water, and charging it with washed carbonic acid under a pressure of seven atmospheres.

ACIDUM CITRICUM, *P.B.* *Citric Acid.*

$3HO,C_{12}H_5O_{11}+2HO=192+18$, or $\mathbf{H_3C_6H_5O_7+H_2O}=192+18$.

F. *Acide Citrique.* G. *Citronensaüre.*

A crystalline acid prepared from lemon-juice or from the juice of the fruit of *Citrus Limetta*, Risso, the Lime.

Citric acid, so called because it abounds in the genus Citrus, is also contained in the juice of some other fruits, as in acid grapes, in tamarinds, in the gooseberry, red currant, cranberry, bird-cherry, usually mixed with some malic acid, sometimes combined with potash or with lime. In the juice of lemons and limes it is in a free state, mixed only with mucilage and similar vegetable impurities, which prevent its crystallising. It was first separated from these and obtained in a solid form by Scheele, in 1781. Citric acid is best isolated by the following process:—

Preparation.—Heat 4 pints of *lemon juice* to its boiling point, and add 4½ ounces of *prepared chalk* by degrees till there is no more effervescence. Collect the deposit on a calico filter, and wash it with hot water till the filtrate passes colourless. Mix the deposit with a pint of distilled water, and gradually add 2½ fluid ounces of *sulphuric acid* previously diluted with a pint and a half of water. Boil gently for half-an-hour, keeping the mixture constantly stirred. Separate the acid solution by filtration, wash the insoluble matter with a little water, and add the washings to the solution. Concentrate this solution to the density of 1·21, then allow it to cool, and after twenty-four hours decant the liquor from the crystals of *sulphate of lime* which will have formed; further concentrate the liquor until a film forms on its surface, and set it aside to cool and crystallise. Purify the crystals if necessary by recrystallisation.

The citric acid displaces the carbonic acid with effervescence, and the insoluble citrate of lime ($Ca_3 2C_6H_5O_7,4H_2O$) is precipitated as fast as it is formed. This is washed from traces of sugar and malate of lime, which is sometimes present. By boiling with a slight excess of sulphuric acid the citric acid is displaced, and remains in the solution from which the calcic sulphate deposits. After the latter has been separated by decantation, the citric acid and a slight excess of sulphuric acid remain in the solution: the presence of the latter favours the crystallisation of the former.

Characters and Tests.—Colourless crystals, of which the right rhombic prism is the primary form, soluble in ¾ their weight of cold and in ½ their weight of boiling water; less soluble in rectified spirit; insoluble in pure æther. The diluted aqueous solution has an agreeable acid taste. A solution of 34 grains of the acid in 1 ounce of water resembles lemon juice in the degree of acidity, and in becoming mouldy by keeping. The aqueous solution is not darkened by sulphuretted hydrogen (absence of metallic impurity), gives no precipitate when added in excess to solution of acetate of potash (absence of tartaric acid), or of chloride of barium (freedom from sulphuric acid), and if sparingly added to cold lime water, does not render it turbid (absence of tartaric acid). The crystals leave no ash when burned with free access of air (absence of earthy impurity). 70 grains of the acid dissolved in water are neutralised by 1000 grain measures of the volumetric solution of soda.

A dilute solution of citric acid becomes mouldy and decomposes into carbonic and acetic acids. Citric acid dissolves zinc and iron with evolution of hydrogen. It is most readily oxydised; thus nitric acid, and even plumbic dioxyde or manganic oxyde, convert it at an ordinary temperature into a mixture of acetic, oxalic, and carbonic acids. Heated to 104° with sulphuric acid, pure carbonic oxyde is evolved, and at a higher temperature acetone (C_3H_6O)

and carbonic acid. Heated with caustic potash, citric acid is converted into *acetate* and *oxalate* of *potash*—

$$H_3C_6H_5O_7 + 4KHO = 2KC_2H_3O_2 + K_2C_2O_4 + 3H_2O .$$

The action of heat on citric acid is interesting; for some acids found in other plants are formed in the process. Thus, when heated to 347°, acetone, carbonic oxyde and anhydride gases, and water are evolved, and aconitic acid, with a little charred matter, is left. *Aconitic acid*, $H_3C_6H_3O_6$, differs from citric acid in having a molecule less of water. It is isomeric with fumaric and maleic acids. Aconitic acid is decomposed at a higher temperature into carbonic anhydride, and two isomeric acids, *itaconic* and *citraconic.*

CITRATES.—Citric acid is tribasic, and, like phosphoric acid, forms three varieties of citrates,—Trisodic citrate, $Na_3C_6H_5O_7,Aq$; disocic hydric citrate, $Na_2HC_6H_5O_7,Aq$; and sodic dihydric citrate, $NaH_2C_6H_5O_7,Aq$. The citrates of the alkali metals are soluble; those of zinc, lead, and copper are slightly soluble; ferric citrate is very soluble: it is indeed remarkable that free citric acid, or a soluble citrate, prevents the precipitation of ferric oxyde and alumina, as well as some other metallic oxydes, by excess of ammonia (see p. 219). Tartaric acid and soluble tartrates have the same effect (see p. 219). The citrates of baryta strontia, lime, magnesia, are insoluble, unless excess of citric acid be present. When citric acid is added to cold lime water short of neutralising the latter, no precipitate is produced until the solution is boiled, the calcic citrate being slightly soluble in cold, but insoluble in hot water.

Test.—Citric acid is liable to adulteration with tartaric acid, which is readily detected by any soluble salt of potash; or an excess of lime water.

Incompatibilities.—Alkalies and earths, and their carbonates; most acetates; tartrate of potash, which precipitates cream of tartar.

Action.—That of lemon juice.

The following table of saturation will be found useful in prescribing the acid or juice:—

20 grs. of Citric acid saturate.	And 20 grs. respectively of the Carbonate saturate.
29 grs. Bicarb. of potash	14 grs. of Citric acid, or 2½ fl. drs. Lemon juice.
24 ,, Carb. ,, potash	17 ,, ,, 4 ,, ,,
41 ,, Carb. ,, soda	10 ,, ,, 2½ ,, ,,
24 ,, Bicarb. ,, soda	17 ,, ,, 4 ,, ,,
17 ,, Carb. ,, ammon.	24 ,, ,, 6 ,, ,,

Pharmaceutical Uses.—Citric acid is employed in the preparation of Syrupus limonis, Vinum quiniæ, Liquor ammoniæ citratis, L. bismuthi et ammoniæ citratis, Ferri et ammoniæ citras, F. et quinæ citras, Lithiæ citras, Potassæ citras, and Sodæ citro-tartras effervescens.

CITRUS MEDICA, *Risso.* The Citron. F. *Cedrate.*

The fruit often weighs several pounds; the citron is distinguished by its large ovoid fruit, with extremely thick rind and proportionately small quantity of acid juice. This name has been erroneously applied to the species yielding lemons. The rind is thick and spongy internally, tuberculated externally, and covered with numerous dots filled with essential oil (*huile de cedrat*). Its pulp is less acid and juicy than that of the lemon. The rind of the fruit is preserved, and its essential oil separated; the juice may be employed for the same purposes as that of the lemon.

CITRUS BERGAMIA, *Risso.* The Bergamot.

This small tree is unknown in the wild state, and is regarded by Gallecio as a hybrid between the orange and lemon. It is cultivated on the Calabrian coast, at and near Reggio, for the sake of its volatile oil.

Characters.—*Leaves* oblong, elongated, paler on the under side; *petiole* winged or margined. *Flowers* small, white. *Fruit* pyriform or depressed, pale lemon-yellow. *Pulp* acid and bitterish.

1. **Oleum Bergamottæ.** *Essence of Bergamot.* F. *Essence de Bergamotte.* G. *Bergamottöl.*

The oil is stored in the receptacles of the rind, and is obtained by rasping the fruit in a rotatory iron mill, furnished with a number of sharp ridges about ¼ of an inch high. About six of the fruits are operated upon at a time, and the oil as it is liberated trickles through an aperture in the lower plate of the horizontal mill, and collects in a proper receptacle. 100 fruits yield about 2½ ounces of the oil. It is pale greenish-yellow, very fragrant, of sp. gr. 0·88; miscible with rectified spirit, oil of turpentine, and glacial acetic acid. It has the same composition as the oils of turpentine and lemon, viz. $C_{10}H_{16}$.

Adulterations.—It is almost invariably adulterated with inferior oil, obtained by distilling the leaves and peel of the residual fruits, or it is mixed with oil of turpentine. The odour of the latter may be perceived by rubbing a drop of the adulterated oil in the palm of the hand. A little of the genuine oil should be kept for comparison.

Uses.—On account of its fragrance oil of bergamot is much used in perfumery, and to give an agreeable odour to liniments and ointments.

ÆGLE MARMELOS, *Decand.* Indian Bael or Bengal Quince.

This aurantiaceous tree is common in India, and held sacred by the Hindoos. It is native of Coromandel and Malabar.

Characters.—A large erect *tree*, furnished with simple axillary thorns. *Leaves* ternate, obscurely dotted. *Flowers* large white, in axillary or terminal panicles. *Calyx* 4–5 toothed. *Petals* 4–5, spreading. *Stamens* numerous. *Ovary* 8–15 celled. *Style* short; *stigma* capitate. *Fruit* hesperidate, with a hard rind. *Seeds* 6–10 in each cell, compressed, oblong, woolly, imbedded in a clear, very tenacious mucus. —*Pharm. Journ.* vol. x. p. 166.

1. **Belæ fructus,** *P.B.* *Bael Fruit.*

The dried half-ripe fruit of the plant above described, from Malabar and Coromandel.

Characters and Constituents.—Fruit roundish, about the size of a large orange, with a hard woody rind; usually imported in dried slices, or in fragments consisting of portions of the rind, and adherent dried pulp and seeds. Rind about 1½ line thick, covered with a smooth pale brown or greyish epidermis, and internally, as well as the dried pulp, brownish-orange or cherry-red. The moistened pulp is mucilaginous.

The drug, as we receive it, is destitute of astringency. The pulp and seed coats furnish a large quantity of *mucilage*, some *sugar*, and a *mere trace of tannin.*

Action and Uses.—Bael has been recommended as an astringent in chronic dysentery and in diarrhœa. As an astringent it can be of no use, as a demulcent it may be beneficial in these disorders. An infusion of the fresh fruit forms a pleasant, slightly acidulous, and aromatic drink; but the dried fruit, and the following preparations of it, are merely encumbrances of the Pharmacopœia.

2. **Extractum Belæ liquidum,** *P.B.* *Liquid Extract of Bael.*

Preparation.—Macerate 1 pound of *bael fruit* for twelve hours in 4 pints of *water;* pour off the clear liquor; repeat the maceration a second and a third time for one hour in the same quantity of water; press the marc, and filter the mixed liquors through flannel. Evaporate to 14 fluid ounces, and when cold add 2 fluid ounces of *rectified spirit.*

Each fluid ounce of the extract represents one fluid ounce of bael.

Dose.—1 to 2 fluid drachms.

MELIACEÆ, *Juss.* The Melia Family.

This is a tropical family of Rutal exogens, distinguished by the adhesion of the filaments into a wide tube. It contains many plants, which have acrid, irritant properties, and the majority are bitter and astringent.

1. **Melia Indica** furnishes the *Margosa bark* of the Pharmacopœia of India. The active principle appears to be due to a bitter resin (Broughton). It is used in India as a tonic and antiperiodic.

2. **Soymida febrifuga** yields "Cortex Swieteniæ," or *Rohun bark* of the Indian Pharmacopœia. It contains a very bitter resin and tannic acid, and is much used in India as a tonic astringent and antiperiodic in intermittent fever, dysentery, and atonic diarrhœa.

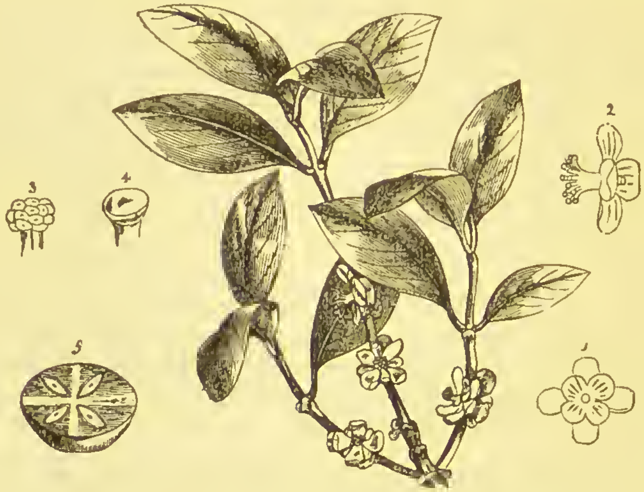
GUTTIFERÆ, *Jussieu.* The Gamboge Family.

These hypopynous exogens are known by their opposite leathery leaves, indefinite stamens, and sessile radiant stigmas. Many species yield, like the gamboge, a yellow juice; the seeds of others are oily. Amongst the edible fruits of the order is the Mangosteen, the produce of *Garcinia Mangostana*, which is esteemed the most delicious fruit in the world. The genus Garcina may be taken as the type of the order.

GARCINIA MORELLA, *Desrous.*, var. PEDICELLATA. The Gamboge Tree.

This tree is native of Siam and Cochin-China, and obtains its name from Cambodia, a province of the former country, or the river Camboja, which flows through it, whence the drug was first derived. It is a diœcious tree, with foliage resembling the laurel, and small yellow flowers, ripening its succulent fruit in July.

Characters.—A medium-sized *tree*, 35 to 50 feet high. *Leaves* coriaceous, obovate, elliptical, abruptly subacuminate. *Male flowers* in axillary clusters, on short 1-flowered pedicles. *Sepals* 4, yellow internally, yellowish-white externally, persistent; *petals* 4, yellowish-white, red at the base. *Stamens* numerous, filaments short; *anthers* peltate, many celled, dehiscing circumscissily. *Female flowers* sessile; *pistil* surrounded by the abortive stamens. *Stigmas* 4, large, sessile, 2-lobed, lobes crenate. *Berry* about the size of a cherry, round, firm, externally reddish-brown, containing a sweet pulp, 4-celled, cells 1-seeded.—*Desrosseaux*, in *Lamark. Encyclop. Méthod. Bot.* iii. 701, pl. 405, fig. 2 (*G. Morella*); *Graham*, in *Hooker's Companion to Bot. Mag.* ii. (1836) 193, pl. 27 (*Hebradendron cambogioides*); *Hanbury, Lin. Soc. Trans.* vol. xxiv. tab. 50.



Fig, 121.—*Garcinia Morella.* 1, female flower; 2, male do.; 3, stamens; 4, an anther, showing the transverse dehiscence; 5, fruit in section.

This tree is full of a milky yellow juice—liquid gamboge—which is chiefly secreted in large vessels contained in the bark. It is obtained by making an oblique incision in the bark, extending half round the trunk of the full-sized tree, and fixing a joint of bamboo at the lower end of the cut. A yellow fluid slowly exudes, and as it collects in the receptacle placed for it gradually concretes into solid gamboge. The yield of one season will, on the average, fill three joints of a bamboo about 1½ inch internal diameter. In Cochin-

China the yellow juice which exudes from the broken leaves and twigs is allowed to flow upon the leaves of the tree or into cocoa-nut shells. It is then collected and placed in earthen vessels, in which it hardens by exposure. The masses thus formed are enveloped in leaves. Gamboge is stated by Murray (*App.* 4, p. 110) to have been first introduced to the notice of Europeans by Clusius, who received it from China in 1603. It is known in India by the name of *ossareh rewund*, or juice of rhubarb.

In Ceylon gamboge is obtained from *Garcinia Morella* (fig. 121), the male flowers of which are sessile. Colonel Walker informed Dr Wight that this tree is found in great abundance along the western and eastern coast in the neighbourhood of Battacola, as well as inland, especially in low sandy ground, about Kanderaane, Negombo, and towards Chilau; also 100 miles inland, at so high an elevation as 2000 feet above the sea. Mrs Walker says, the gamboge is collected by incisions into the bark, or by cutting pieces off about the size of the palm of the hand, early in the morning. The gamboge oozes out in a semi-liquid state, but hardens on exposure to the air, and is scraped off by collectors next morning. She describes it as brilliant and excellent, and as good for water-colour drawing as any she had used. The Ceylon gamboge is found in the bazaars of India, but is seldom met with in Europe. Mr Charles Groves of Liverpool informed Dr Royle in 1832, that when engaged in the trade of Ceylon he had sent a considerable quantity of the gamboge of that island to London, but it was found to be unsaleable from its inferior quality.

In India gamboge is derived from the following species of Garcinia:—

1. *G. Morella* var. *pedicellata*, the plant which furnishes the Siam gamboge, and introduced from that country into Singapore by Dr Almeida in 1869.

2. *G. pictoria.*—This tree furnishes *Coorg* or *Wynaad gamboge*, which Mr Dyer and Sir R. Christison consider to be equal to the Siam product. Good specimens were sent to the Great Exhibition in London in 1851, and excellent samples from Mysore to the Paris Exhibition in 1855. The following are the characters of this plant. The figure is from a drawing of the foliage and fruit sent to Dr Royle by Mr Dyer of Tellicherry.

Characters.—A tall *tree*, with a thick bark containing considerable masses of gamboge in the interior. *Leaves* with short petioles, acute, from 3 to 4 inches long by 1½ or 2 broad. *Flowers* yellow, axillary, solitary. *Calyx* permanent of 2 pairs of concave obtuse sepals. *Petals* 4. *Stamens* from 10 to 15, filaments united into four, and at the base into a narrow ring. *Anther* of the male flower peltate, of the female 2-lobed and seemingly fertile. *Ovary* superior, round, 4-celled, one ovule in each attached to the axis a little above its middle. *Stigma* 4-lobed, permanent. *Berry* size of a large cherry, oval, smooth, very slightly marked with four lobes, crowned with the sessile, 4-lobed verrucose, permanent stigma. *Rind* leathery, of a reddish colour. *Seeds* 4, when all ripe oblong-reniform. The filaments in the male flowers are described as being numerous and the anthers peltate.—*Roxburgh, Flora Indica,* ii. p. 627; *Wight, Icones,* vol. i. t. 102.

Hab.—Malabar and Wynaad jungles and the Mysore ghauts. It is also found near Mengui in Tavoy.

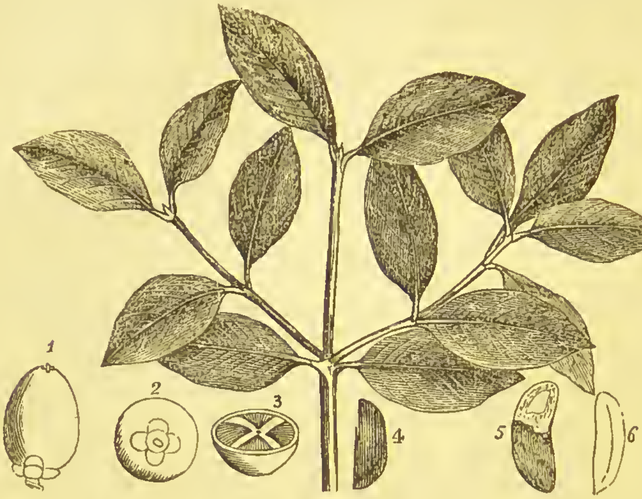


Fig. 122.—*Garcinia pictoria.* 1, 3, fruit; 2, shows the calyx; 4, 5, 6, seeds.

3. *G. Travancorica* (Beddome, *Flora Sylvatica*, Madras, pl. 173), is a fine tree, inhabiting the southern forests of Travancore and the Tinnevelly ghauts at an elevation of 4000 feet, and yields an abundance of gamboge.

4. *G. elliptica* a native of Silhet and Tavoy, also yields gamboge.

1. **Cambogia.** *P.B.* *Gamboge.*

A gum resin obtained from *Garcinia Morella* var. *pedicellata.* Imported from Siam.

Characters and Tests.—In cylindrical pieces, breaking easily with a smooth conchoidal glistening fracture; colour tawny, changing to yellow when it is rubbed with water; taste acrid. The powder irritates the Schneiderian membrane, causing a flow of mucus. An emulsion made with boiling water and cooled does not become green with the solution of iodine (absence of starch). Gamboge is composed of *resin* and *gum* in the proportion of about 80 of the former to 20 of the latter (see below). The resin is soluble in solution of potash, forming a deep red liquid; the addition of an acid precipitates the resin. The stick or cylinder gamboge above described is the finest quality; lump gamboge is often impure. The Cambodians themselves sometimes adulterate it with rice flour, or the powdered bark of the tree. These adulterations remain undissolved after the powdered gum resin has been successively exhausted by alcohol and water; and the presence of the former is indicated by the iodine test and the microscope: powdered gamboge, which becomes green when emulsified with an aqueous solution of iodine, will, after the application of this test, show blue starch granules when sufficiently magnified.

Varieties of Gamboge.—SIAM GAMBOGE, that just described, occurs in the following forms:—

1. *Pipe gamboge*, in sticks or cylinders, either solid or hollow in the centre, varying in length, and in thickness from ½ to 2 inches, striated externally, evidently from the impressions of the bamboo mould into which it was run when soft. Sometimes these cylinders are doubled upon themselves, at others stuck together, all generally of fine quality. 2. *Lump* or *cake gamboge* occurs in round cakes or masses, several pounds in weight, most commonly inferior in quality to the former, and often mixed with impurities, as fecula and woody fibre. 3. *Coarse gamboge* is formed of the fragments and inferior pieces of the other, which are, however, often mixed with impurities, and not entirely soluble in æther and water.

CEYLON GAMBOGE, though rare in European commerce, is sometimes seen in irregular masses, often cavernous, or with many sinuous hollows, like the sponge, probably from having oozed out irregularly; the colour a uniform yellow, except on the parts exposed to light, where it is darker; brittle in texture. There seems to be no difficulty in obtaining it in a pure state, and if so it might become an article of commerce from Ceylon. The pure pieces were found by Christison to be identical in composition and purgative properties with the gamboge of Siam.

The following analyses are by Sir R. Christison:—

Pipe Gamboge of Siam.		Cake Gamboge of Siam.		Ceylon Gamboge.	
Resin, . .	72·2	Resin, . .	64·8	Resin, . .	75·5
Gum, . .	23·0	Gum, . .	20·2	Gum, . .	18·3
Moisture, .	4·8	Fecula, . .	5·6	Cerasin, .	0·7
		Lignin, . .	5·3	Moisture,	4·8
		Moisture, ..	4·1		

Action. Uses.—A drastic hydragogue purgative, and anthelmintic. Useful in obstinate costiveness, amenorrhœa, and dropsy. It is rarely given alone, as it acts better in combination, as in the following pill originally introduced by Dr G. Fordyce, and to which Morison's Pills are similar.* An alkaline solution has been employed on the Continent as a powerful diuretic.

Dose.—1 to 4 grains, in combination with calomel, scammony, and aloes.

2. **Pilula Cambogiæ composita,** *P.B. Compound Gamboge Pill.*

Preparation.—Mix together 1 ounce each of *gamboge, Barbadoes aloes,* both in powder, and *compound powder of cinnamon,* with 2 ounces of *hard soap,* using sufficient *syrup* to form an uniform pill mass.

Dose.—5 to 10 grains.

GARCINIA INDICA, Choisy (*Flor. Brit. Ind.* i. 261; Beddome, *Icones,* pt. 276).—This tree is a native of the Concans. The seeds furnish a bland solid fat, called *Kokum butter*, and *Concrete oil of Mangosteen.* On this account the seeds are included in the Indian Pharmacopœia. The fruit, which is about the size of an apple, contains 8 seeds, each of which is kidney-shaped, compressed and wrinkled, and about ¾ inch long. The cotyledons contain a crystalline fat. The fat is extracted by boiling the crushed seeds in water. The oil collects on the surface, and is removed as a solid cake on cooling. It is a white compact crystalline, odourless, and tasteless fat, composed of stearin, with a small proportion of olein, melting at 112.° The seeds yield about 30 per cent. of this fat.

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* In the trial of Morison and Others *v.* Harmer and Bell, the late Professor Daniell, in analysing twelve of Morison's pills, No. 2, found of resin of aloes $5\frac{6}{10}$ grs., resin of gamboge $4\frac{1}{10}$ grs., pounded colocynth 2 grs., gum $4\frac{7}{10}$ grs., and of cream of tartar $6\frac{7}{10}$ grs.

It is not so well adapted for pharmaceutical uses as cocoa-butter, because if it be kept some time it develops a rancid odour.

DIPTEROCARPACEÆ, *Blume.* Dipterocarps.

Gigantic trees abounding in resinous juice, natives of India and the eastern islands of the Indian Archipelago. They are known from Guttiferæ by their convolute stipules, and the two-winged fruit—the two wings being formed to the adherent and unequally developed limbs of the calyx, and crumpled or twisted cotyledons.

DIPTEROCARPUS, *Blume,* SPECIES VARIÆ. Gurgun Balsam Trees.

The balsam is furnished by the following species:—*D. alatus*, Roxb.; *D. gracilis*, Blume; *D. hispidus*, Thw.; *D. incanus*, Roxb.; *D. Indicus*, Bedd.; *D. littoralis*, Blume; *D. retusus*, Blume; *D. trinervis*, Blume; *D: turbinatus*,. Gärtn.; and *D. Zeylanicus*, Thw. The genus is named from two conspicuous wing-like and often coloured appendages to the fruit. The species flourish in Chittagong, Pegu, Burmah, Java, Ceylon, and Eastern Bengal.

The balsam also called *Wood oil* and *Goa oil*, and now included in the Pharmacopœia for India.

It is obtained by making excavations in the wood of the living tree, and charring the cavity, when the balsam begins to exude. Roxburgh states that a single tree will sometimes furnish as much as 30 or 40 gallons in the course of one season; and the oil may be extracted from the same tree year after year.

Gurjun balsam resembles copaiba balsam, and is sometimes called *East Indian balsam of copaiba.* It resembles copaiba in odour and in taste, the odour, however, being weaker; sp. gr. 0·96. It is distinguished from copaiba by the effects of heat. Copaiba may be heated in a closed vessel to 400° without losing its fluidity; but Gurjun balsam, under the same circumstances, becomes a solid jelly, and does not recover its fluidity.

Subjected to distillation, gurjun balsam is separated into volatile oil, of which the balsam contains 37 per cent. and a dark viscid resin. The oil has the same composition as oil of copaiba, $C_{20}H_{32}$. The resin contains a little crystallisable *gurgunic acid*, $C_{44}H_{68}O_8$, which appears to be a hydrate of abietinic acid. It is soluble in alcohol and æther, neither of which dissolve the amorphous resin.

Action and Uses.—Those of balsam of copaiba for which it is substituted. Dr Dougall advocates its use in leprosy. He gives it in the form of emulsion with lime water to the extent of 9 drachms a day, and anoints the body with the same mixture. Gurjun balsam is also used as a varnish to protect timber from the ravages of the white ant.

DRYOBALANOPS AROMATICA, *Gærtn.* The Borneo Camphor Tree.

This is one of the giants of the vegetable world, and is no less magnificent than beautiful. It rears its majestic trunk bare and straight to a height of 100 or 150 feet, and then spreads out its branches into a dense head 50 feet or more in diameter, of shining foliage interspersed with fragrant white flowers. It is a native of the northern parts of Borneo, of Labuan, and of the north-western coast of Sumatra. The trunk of this tree contains a fluid hydrocarbon called *camphor oil* or *borneene*, $C_{10}H_{16}$, therefore isomeric with oil of turpentine; and a solid crystalline camphor, called *borneol* or *camphol*, $C_{10}H_{18}O$. It is harder and a little heavier than common camphor, and is not sufficiently volatile to crystallise on the sides of the bottle in which it is kept; it fuses at 388°·4. It resembles ordinary camphor in odour, but is more fragrant. Gently warmed with nitric acid it is converted into common camphor by the abstraction of 2 atoms of hydrogen. It is, therefore, regarded by chemists as an alcohol—*camphylic alcohol*, of which common or laurel camphor is the aldehyd.

If borneene be repeatedly distilled from a solution of potash, it assumes an atom of water, and is converted into borneol.

Borneo camphor is a costly production, and is not found in European commerce. It may be used for the same purposes as ordinary camphor.

The liquid camphor or oil might no doubt be beneficially employed for the same purpose as cajaputi oil and grass oil. The Sumatra camphor does not appear to be preferable to that of China.

The Dipterocarpaceæ furnish several other important products, as the resin or dammar of *Shorea robusta;* and Indian copal (sometimes mixed with amber and sold as such), which is the liquid varnish, inspissated, of the Piney tree, or *Vateria Indica*, of which the fruits yield to boiling water the esteemed and valuable vegetable butter of Canara.

TERNSTRŒMIACEÆ, *Mirbel.* The Tea Family.

These plants belong to the Guttiferal alliance, from the foregoing and other orders of which it is distinguished by alternate, generally exstipulate leaves, versatile anthers, and a long style. The single-flowered Camellias of our gardens may be taken as a type of the order.

THEA BOHEA, T. ASSAMICA, T. VIRIDIS. Tea Plants.*

Two plants are known in the gardens: one of which, called *Thea viridis*, was supposed to yield only green tea, including—1. Imperial. 2. Gunpowder. 3. Hyson. 4. Young Hyson. 5. Twankay. This kind is capable of withstanding a greater degree of cold, and survives through the winter in the open air in this country, as may be seen in Kew Gardens. Green teas, we know, are chiefly produced in the more northern districts of China. Some are factitiously coloured with indigo and sulphate of lime, and Mr Warrington has ascertained that of the green teas of commerce some are *unglazed*, others *glazed*. The former are of a yellow-brown tint tending on the rubbed parts to a blackish hue, without a shade of green or blue; while the *glazed* are faced or covered superficially with a powder consisting of Prussian blue and sulphate of lime or kaolin, with occasionally a yellow or orange-coloured vegetable substance (turmeric?). Indigo with gypsum is sometimes used, as by the China tea-makers sent to Assam. Even the *unglazed* have a little sulphate of lime attached to their surface, either to act as an absorbent of moisture, or to give the bloom characteristic of the green teas of commerce. The *Thea Bohea* appears distinct as a species from the former, and has been supposed to yield the different kinds of Black tea—that is, Pekoe, Lapsang, Souchong, Congou, Bohea, &c.; the last being the inferior, and the Pekoes the best kinds of Black tea. Plants collected in Chusan are somewhat intermediate in character. That growing wild in Assam is considered by some botanists to be another distinct species, *Thea Assamica*. Mr Ball has fully explained, in his work on the subject, the processes of manufacture by which both Black and Green teas are produced from the leaves of the same plant. Mr Fortune (*Visit to the Tea Countries of China*) has placed beyond a doubt the fact that all the best black and green teas are prepared by the Chinese from the leaves of varieties of *T. viridis*, which alone are cultivated in the north of China. *T. Bohea* is chiefly grown in the neighbourhood of Canton. The difference between black and green tea mainly depends upon the fact of the black tea leaves having been exposed to the air, and suffered to undergo a kind of fermentation, before the process of heating.

Some tea has been manufactured in the Government nurseries in Kumaon from plants grown from China seed, which has been pronounced of the finest quality by the best judges, and compared with the Oolong teas of the Ankoy district. Some prepared in August 1845, in the tea nursery in the Deyra Doon, has also been pronounced of fine quality, and compared with Orange Pekoe. *Thea Assamica*, a large-leaved species, yields the tea of the province of Assam.

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* A most valuable account of tea is given by Dr Royle in his *Illus. of Himalay. Bot. and Productive Resources of India.*

Constituents.—The properties of tea depend chiefly on the presence of *tannin*, of a *volatile oil*, and of a principle called *theine*, which is identical with *caffeine*, the essential constituent of coffee.

Theine or Caffeine, $C_8H_{10}N_4O_2,H_2O = 194 + 18$, is found in several other plants besides the tea, coffee, and cocoa shrubs (theobromine). The fruit of the *Paullinia sorbilis*, from which *guarana*, a kind of chocolate, is prepared, contains, according to Stenhouse, 5 per cent.; and it is the essential principle of the *Ilex Paraguayensis* (*Maté* or Paraguay tea), and the *Kola-nut*, used, the first by the natives of South America, and the latter by the inhabitants of Central Africa, as substitutes for tea. The quantity of theine contained in tea amounts to 3 or 4 per cent. It may be readily obtained from a strong infusion of the leaf, after removal of the tannic acid and colouring matter by tribasic acetate of lead. The solution, when concentrated, yields the theine on cooling in long, white, silky needles, having a mild bitter taste. It is sparingly soluble in cold water and alcohol, but freely so in both at a boiling heat; it is soluble in æther, and separates from both alcohol and æther in the anhydrous state. When heated, it fuses and sublimes without decomposition. Its basic properties are feeble, forming crystalline salts with sulphuric and hydrochloric acids, which are decomposed when dissolved in water. Theine differs from theobromine (see p. 708) by a molecule of methylene (CH_2), and when boiled with caustic potash, methylia is liberated. According to Rochleder, the products of the oxydation of theine resemble those of uric acid; they are, in fact, substitution products from the same organic group. Thus nitric acid decomposes theine with the evolution of peroxyde of nitrogen and the formation of a compound, which, on the addition of ammonia, develops the splendid purple colour which characterises a solution of murexid, obtained by the same means from uric acid. The purple reaction, showing the presence of *theine murexid*, is most readily developed by adding theine to a mixture of hydrochloric acid and potassic chlorate, evaporating to dryness, and then adding ammonia. *Amalic acid* is the intermediate product corresponding to alloxan, and like this body, it stains the skin pink.

The aroma of tea is due to the *volatile oil*. It exists in the proportion of 0·79 per cent. in green tea, and 0·6 in black (Mulder). The *tannic acid* forms from 13 to 18 per cent. The dried leaf also contains 28 per cent. of *albumin*.

Action.—The volatile oil is a powerful stimulant and inebriant, and it is on this account that the dried leaf is not used in China until it has lost a considerable portion of this constituent by keeping it for a year. Owing to the large quantity of tannic acid contained in tea it is a powerful astringent, and as tea is so frequently and constantly used, this property must not be overlooked. Constipation is not the only result of this oversight, for we now and then discover that a patient who is unable to digest any kind of solid food, is inadvertently swallowing leather formed by the addition of jelly (gelatin) to a cup of strong tea.

But the essential properties of tea depend on theine. The effects of this alkaloid are evidently the result of a stimulant and tonic action on the nervous system generally; the cerebral functions are stimulated, the motor activity increased, and the reflex movements are accelerated—the result being a general feeling of refreshment and invigoration. In excessive doses and in the lower animals these effects are very observable, and may rise to wakefulness or even slight delirium and restlessness, with cardiac and pulmonary excitement. In delicate and highly nervous persons strong tea and coffee commonly produce wakefulness and restlessness, often with distressing palpitation; and these effects are most marked in persons who inherit a tendency to irritability of the reflex movements; thus I have known attacks of sneezing, hiccup, or respiratory oppression to be invariably induced by the ordinary use of tea or coffee in certain persons who inherit a tendency to spasmodic asthma, but who are otherwise robust and destitute of "nervousness" in the ordinary sense of that word. The absurd theory that the *stimulant effects* of theine are due to a *diminution of the oxydising processes* has been disproved by several observers (see *e.g.* a paper by Dr Squarey, *Trans. Roy. Med. and Chir. Soc.* vol. xlix.), who find that the urea undergoes no diminution.

Uses.—From the foregoing observations it will be obvious that there are many persons and many morbid conditions in which the use of tea and coffee are contraindicated; and since the effects of the abuse of these natural beverages may not, and indeed often are not, attributed to their proper cause, the medical attendant will often find it necessary to exert uncommon vigilance in tracing them to their real source, and especially so because persons exhibit unwonted, and if we do not know their antecedents, unexpected idiosyncrasies with respect to theine. As a general rule, the use of tea and coffee is contraindicated in those who sleep lightly, and who are liable to emotional disturbance of the heart or lungs, as in hysteria, or who suffer from attacks of palpitation dependent on valvular disease. As a general nervine stimulant, tea has proved beneficial in many disorders of the nervous system dependent on depression of nerve power; thus in headache and neuralgia proceeding from exhaustion, it gives great relief. Its influence in these conditions resembles that of quinia, and indeed the use of strong coffee has been found decidedly beneficial in the treatment of intermittent fever. In the treatment of continued fever, and the prostration of acute diseases generally, the influence of tea and coffee is commonly overlooked and attributed to other medicines; but there is no doubt that the judicious use of these beverages contributes largely to the sustenance and restoration of the nerve power. It would be well, indeed, if they were employed in these conditions in a more systematic manner, and in the place of other remedies, such as ammonia, which is often prescribed when the condition of the patient is averse from its use. As a means of arousing the nervous system when oppressed by narcotics, coffee and tea are valuable, and so also in spasmodic asthma, when the patient is exhausted by the attack, and the bronchial muscular fibre wants the stimulus and tone required to relieve the lungs of accumulated secretion.

Doses.—In using tea medicinally, prolonged infusion must be avoided, to prevent as much as possible the solution of astringent matter, unless, as in enteric fever, or poisoning by the alkaloids and metallic salts, the ingestion of tannic acid is desired. In cases where from prostration, deglutition is difficult, theine may be given in solution in a small quantity of fluid, or subcutaneously. The dose by the mouth is from 1 to 4 grains, by the subcutaneous tissue $\frac{1}{4}$ to 1 grain.

In poisoning by narcotics, strong black coffee or tea should be given, after evacuation of the contents of the stomach, freely and after short intervals. For medicinal use "green tea" is most appropriate.

SAPINDACEÆ, *Juss.* Soapworts.

The general characters of this order are well illustrated in the horse-chestnut. They are called soapworts, because the fruits of many species contain a saponaceous principle, by virtue of which they form a lather with water. The order is known by their unsymmetrical flowers, the appendages of the petals, arillated seeds, and a curved embryo, which in the snake-nut is coiled up. It furnishes a variety of dissimilar products, amongst which may be enumerated the delicious "litchi-nuts" and its allies the produce of species of Nephelium; the arrow-poison of Guiana, prepared by the natives from *Paullinia Cururu*, and other species; and the Guarana bread. Through several genera the order closely approaches the Aceraceæ.

ÆSCULUS HIPPOCASTANUM. The Horse-chestnut.

The bark of this plant or the husk of the seed is bitter and astringent, and the kernel contains a little of the saponaceous principle which is so largely found in some plants of this order. The bark also contains the remarkable glucoside called *esculin* or *polychrome* $C_{21}H_{24}O_{13}$, a bitter crystalline substance, very soluble in water, and remarkable for the fluorescent power of its solution, which is colourless by transmitted, and deep blue by reflected light. Acids destroy this property and alkalies increase it. When boiled with acids esculin is resolved into glucose, and esculetin, $C_9H_6O_4$, which separates from alcohol in laminæ, resembling benzoic acid. It forms with alkalies solutions of a golden-yellow colour.

Uses.—The bark (as an infusion, 1 ounce to 10 ounces of boiling water) has been prescribed as a tonic and febrifuge.

PAULLINIA SORBILIS. The Guarana.

The seeds of this plant furnish the Guarana bread so highly esteemed by the natives of Brazil. The seeds contain a considerable quantity of fixed oil, a little resin, starch, and gum, and about 5 per cent. of *theine* (see p. 705), and it is to this last named constituent that its valuable properties are due. The Brazilians form the pounded seeds into round or oblong cakes (Guarana bread), and when they use it they form an emulsion by pounding a portion in water and sweetening the fluid. "Guarana paste," formed by mixing the powdered seeds with water and drying the mass in the sun or by a fire, occurs in the form of hard brownish-black cakes resembling cocoa, of a bitterish astringent taste and peculiar odour, partly soluble in water. It may be used as cocoa.

Action and Uses.—See Theine. The Brazilians esteem Guarana to be stomachic, febrifuge, and aphrodisiac.

BYTTNERIACEÆ, *R. Brown.* The Cocoa Family.

These plants belong to the Malval alliance, and are distinguished by their monadelphous stamens and 2-celled introrse anthers.

THEOBROMA CACAO, *Linn.* Cocoa or Cacao-tree.

This small tree furnishes a product which is extremely useful both as food and medicine. It is a native of Mexico, but extensively cultivated in the West India Islands, and is remarkable for its yellow cucumber-like capsules, hanging from the sides of the trunk and branches.

Characters. — *Leaves* large, oblong-lanceolate. *Flowers* in axillary clusters, reddish. *Sepals* and *petals* 5. *Stamens* 15, adherent at the base. *Style* 5-fid. *Fruit* indehiscent, oval, large, yellow, with a thick fleshy *capsule*, 5-celled, each cell having from 8 to 10 ovoid *seeds*, piled one upon another, and covered by a membranous and succulent aril.

1. **Theobromæ semina.** *Cocoa Seeds.*

They contain about 88 per cent. of kernel, and this yields 55 per cent. of "*cocoa-butter*," 17 of vegetable albumin, 22 of sugar, gum, starch, and cellulose, and from 1·2 to 1·5 per cent. of *theobromine.* Cocoa-butter, or oil of theobromine, is described below. Theobromine $C_7H_8N_4O_2$, agrees very closely in its chemical and physiological properties with caffeine or theine, which is in fact a methyle-compound of theobromine. Theobromine is slightly bitter; it is sparingly soluble in boiling water, and still less so in alcohol and æther. The aroma of cocoa is developed by roasting the seed, and "*cocoa-nibs*" are simply the roasted kernels slightly crushed. The other forms of cocoa are made by grinding the roasted kernels into a paste between hot rollers, and mixing it with starch and sugar. *Chocolate* is also an artificial compound, prepared by mixing the cocoa paste, prepared as just mentioned, with sugar, starch, vanilla, cinnamon, &c.

"Much of the common chocolate sold in England is a mixture composed of the cake from which cocoa-butter has been expressed, roasted peas and maize, or potato flour, to which a sufficient quantity of brown sugar or treacle and mutton suet has been added to make it adhere together" (*Cooley*).

Action. Uses.—Both cocoa and chocolate form the basis of very nourishing and agreeable beverages (whence the name of Theobroma, or food for the gods), devoid of the astringent properties of tea and coffee, but apt to disagree with some people on account of the quantity of oily matter they contain.

2. **Theobromæ oleum,** *P.B.* *Oil of Theobroma* or *Cocoa-butter.*

A concrete oil obtained by expression and heat from the ground seeds of *Theobroma Cacao.*

Characters and Constituents.—Of the consistency of tallow; colour yellowish; odour resembling that of chocolate; taste bland and agreeable; fracture clean, presenting no appearance of foreign matter. Does not become rancid on exposure to the air. Melts at about 95°.

The fat is composed of stearin and palmitin, with only a small quantity of olein. By saponification it is resolved into the fatty acids of these compounds and glycerin.

Pharmaceutical Uses.—The preparation of the following suppositories:—Suppositoria acidi tannici, S. hydrargyri, S. morphiæ, in each of which it forms a little less than half the weight.

CISTACEÆ, *Dec.* Rockroses.

This family includes plants which yield *ladanum*, a fragrant resin, formerly celebrated, but now little employed. It is procured in the Levant from species of Cistus, such as *C. creticus*, *C. odoriferus*, &c., and can only be obtained pure in the situations where it is produced. It has a very agreeable odour, from the presence of a volatile oil. It was formerly employed as a stimulant, more recently as an expectorant, and continues to be esteemed by the Turks, who use it as a perfume and fumigation.

MALVACEÆ, *Juss.* The Mallow Family.

Alternate, palmilobed, stipulate leaves; valvate æstivation of the sepals and twisted æstivation of the petals; indefinite monadelphous stamens, with 1-celled reniform anthers, are the distinguishing marks of this order. They are innocuous plants, abound in mucilage, and furnish cotton.

MALVA SYLVESTRIS, *Linn.* **The Common Mallow.**

The mallow is found in most parts of Europe, by hedges, roads, and in waste places, flowering from June to August. It is the Μαλαχὴ κηπϱυτή of Dioscorides. It is not now officinal.

Characters.—The *root* is perennial and branched; the *stem* erect or ascending, branched, the petioles and peduncles hirsute; *leaves* reniform, with 5 to 7 crenate lobes. *Peduncles* axillary, erect, even after flowering. *Calyx* usually surrounded by three narrow bracteoles. *Petals* rose-coloured and purple-veined; the valves of the *carpels* margined, reticulated, and rugose when ripe. —*Eng. Bot.* pl. 671.

Common mallow, like the round leaved and other species, is without odour, but has a mild mucilaginous taste, imparting this property to water, which dissolves the mucilage, its chief constituent, along with a small portion of bitter extractive. Either this or *M. rotundifolia* was employed as an esculent vegetable by the Romans.

Action. Uses.—Demulcent. An infusion of the root sweetened with sugar forms a useful drink when the throat is dry or sore. The decoction may be similarly employed, either for fomentation or injection, or the herb may be formed into an emollient cataplasm.

ALTHÆA OFFICINALIS, *Linn.* Marsh-mallow.
F. *Guimauve.* G. *Eibischwurzel.*

This plant is found in marshy situations in this country and on the Continent, and is the 'Αλθαία of Dioscorides. It is seldom employed in England.

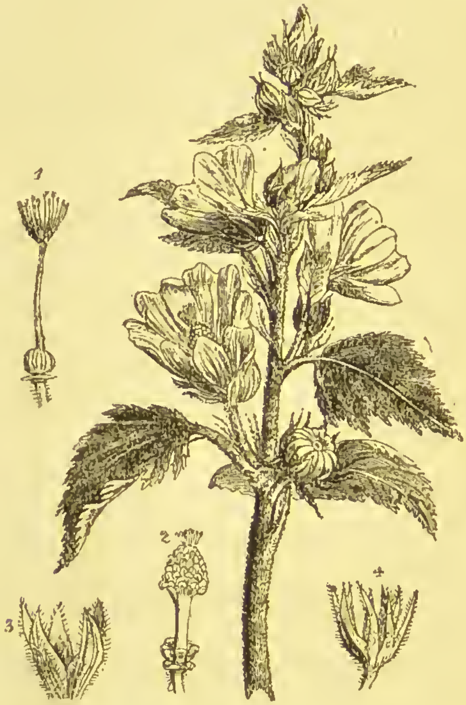


Fig. 123.—*Althea officinalis.* 1, styles; 2, stamens; 3, calyx; 4, involucre.

Characters.—*Root* perennial, tap-shaped, whitish. *Stems* 2–3 feet high, erect, soft, and hairy. *Leaves* soft and woolly on both sides, unequally crenate, cordate or ovate in shape, the lower 5 and the upper 3 lobed; *peduncles* axillary, many-flowered, much shorter than the leaf. *Flowers* of a pale-bluish colour. *Calyx* double, the exterior involucel 6 to 9 cleft, the interior 5-fid. *Carpels* arranged as in Malva.—*Eng. Bot.* pl. 147.

Altheæ radix. *Marsh-mallow Root.*

Characters and Constituents.—The roots, as usually seen, are whitish, being deprived of their epidermis; outside they are naturally of a dirty yellow colour, but white on the inside, long, fusiform, fleshy, and, like the leaves, without odour, but having a bland, mucilaginous, or rather a viscous taste.

They contain 25 per cent. of *bassorin* ($C_{12}H_{20}O_{10}$) or althea mucilage (see Linseed, p. 713), from 1 to 2 per cent. of *asparagin* ($C_4H_8N_2O_3;H_2O$), a neutral inert principle, crystallising in bold, colourless rhombic prisms or octohedra. It is decomposed in contact with albuminous matters into succinate of ammonia, and by the action of acids or prolonged heat into aspartate of ammonia. The presence of the former of these substances in roots that have been long preserved gives the decoction a yellowish colour and rancid taste. The root also contains starch, a little sugar, and fixed oil, and its bark a trace of tannin.

Action. Uses.—Demulcent and emollient. It is used in the form of decoction, syrup, and lozenge.

Syrupus Altheæ. *Syrup of Marsh-mallow.*

Preparation.—Macerate 1½ ounce of *marsh-mallow root*, dried and sliced, in 1 pint of cold *water* for twelve hours. Press out the liquor, and strain through linen. Then add 3 pounds of *sugar*, or twice the weight of the strained liquid, and dissolve with a gentle heat. Lastly, when cold, add ½ fluid drachm *rectified spirit* to each fluid ounce.—(*Pharm. Lond.*)

Dose.—1 to 5 drachms. Chiefly used to allay irritable cough.

GOSSYPIUM, *Linn.* SPECIES VARIÆ. Cotton Plants.

Cotton has been characteristic of India from the earliest times. The first distinct notice of it is in the Book of Esther, i. 6, where its Sanscrit name *karpas* is translated *green* in our Bible. Herodotus and Ctesias notice it; but it was not till the invasion of India by Alexander that the Greeks were acquainted with the plant (see Theophrastus and Pliny). Europe, until lately, has been supplied chiefly from America, where two distinct species are indigenous,—*G. Barbadense*, yielding the cotton from the United States; and *G. Peruvianum* or *acuminatum*, that which is produced in South America. India also has two distinct species, *G. herbaceum* or *Indicum*, the common cotton of India, which has spread to the south of Europe; and *G. arboreum*, or tree cotton, which yields little, if any, of the cotton of commerce.

Characters.—Large or small *shrubs*, one forms a tree. *Leaves* alternate. more or less palmilobed, usually covered, as well as the young branches, with little black dots, and the nerves below have one or more glands. *Calyx* double; the exterior (*involucel*) larger than the interior, in three large leaflets, cordate at the base, entire, toothed, or deeply cut. The interior or *true calyx* is one-leafed, cup-shaped, and with an obtusely quinquifid margin. The *flowers* are large and showy, more or less yellow or red, consisting of five *petals* united at their base, subcordate, flat, and spreading. *Stamens* numerous, filaments united below and adhering to the petals, free above, with small kidney-shaped anthers. *Style* dividing into three, sometimes into five *stigmas*. *Capsule* roundish, oval or pointed, 3 to 5 celled, and 3 to 5 valved at the apex, with loculicidal dehiscence. Each cell contains from 3 to 7 ovoid *seeds*, from the seed-coats of which arise the *coma* or "cotton."

Gossypium, *P.B. Cotton Wool.*

The hairs of the seed of various species of Gossypium, carded.

Characters and Composition.—The hairs, coma, or cotton, consist of tubular fibre cells, readily distinguished by the microscope from the fibres of flax (see p. 713). They are transparent, flattened, and twisted, and present a double contour line. Under water they appear like distinct, flat, narrow ribands, marked at intervals by a transverse line, which indicates the end of a cell. This twisted nature of the cotton fibre is probably the reason why cotton cloth is not so well fitted as linen for surgical dressings. But being a worse conductor of heat than linen, it is well suited for inner clothing, where the object is to preserve uniformity of temperature, as it will retain heat, and protect the body from sudden changes of temperature.

Cotton is almost pure *cellulin*, $C_{18}H_{30}O_{15}$ (see p. 310).

Action and Uses.—Cotton affords a most perfect protection to a painful or excoriated surface, and by preventing excessive evaporation from the skin preserves it from too rapid or too great a reduction of temperature. It is a grateful application to burns, and to tender surfaces produced by erythema, intertrigo, or a blister; and may be very serviceably employed in erysipelas and rheumatic fever. Great comfort is obtained in the latter diseases by enveloping the inflamed joints in cotton wool, and it acts most beneficially by preventing the great changes of temperature to which the sweating parts are so liable. It may be employed to arrest hæmorrhage, as by entangling the blood it causes the more speedy separation of the fibrin and the formation of a clot.

Pharmaceutical Use.—It is employed in the preparation of Pyroxylin (p. 311).

LINACEÆ, *Decand.* The Flax Family.

These plants are closely allied to the Mallows. They are distinguished by the exstipulate leaves, fugitive flowers, imbricated æstivation of the sepals. The stamens are definite, and only united below into a ring. They are distinguished from Geraniaceæ by their distinct styles. The Linaceæ are remarkable for the tenacity of the inner fibre of the bark, for the mucilaginous covering of the seed, and the abundance of drying fixed oil often contained in it. A few are bitter and purgative.

LINUM USITATISSIMUM, *Linn.* Flax.

Flax was cultivated in Egypt at very early periods. It is so at the present day from the north of Europe to the south of India; and it is not, therefore, easy to ascertain where it is indigenous.

Characters.—Annual, with a slender root, small, simple, erect stem, about 1½ feet in height, and terminating in a corymbose panicle of flowers. *Leaves* alternate, sessile, linear-lanceolate, smooth. *Petals* sky-blue, with twisted æstivation, fugitive. *Sepals* ovate, acuminate, nearly equal to the capsule in length. *Capsule* roundish, about the size of a pea, containng 10 seeds (*linseed*) separating into 5 *carpels*, each containing 2 seeds separated by a thin partition. *Seed* with a minute quantity of albumin, forming an investment to the large *embryo*, which is composed of a pair of plano-convex *cotyledons*, converging into a straight pointed *radicle.*—*Woodv. Med. Bot.* pl. 3.

Flax, as it is well known, is prepared from the above plant by steeping, stripping off the bark, and then beating, so as to separate the fibres. Linen and cambric are prepared from it, the latter differing from the former in its fineness, and in being obtained from plants which are more thickly sown. Linen, as clothing, is cool, being a better conductor of heat than cotton; and when the skin is covered with perspiration, or exposed to cold, it feels cool. The fibre of flax is straight, almost solid, soft, and glistening; it is therefore less irritating than the twisted fibre of cotton, from which it is distinguished by its pointed extremities and smooth woody structure. Hence *lint*, which is prepared by scarifying the surface of soft coarsely-woven linen cloth, and then scraping the cut fibres into a downy layer, is so much preferable to cotton for surgical dressings. *Tow* consists of the short coarse fibres of the flax, which are removed in the process of hackling. The finer sorts are of great use to the medical man: thus poultices may be spread upon a plane of tow; it forms a good padding for splints, and should always be used instead of sponges in cleansing wounds. Its employment for this latter purpose, and in place of poultice cloth, cannot be too strongly advocated, for both poultice cloths and sponges are often the means of propagating erysipelas, hospital grangrane, and septicæmia,—bad consequences which could never result from the use of tow, because it is never used a second time.

1. **Lini semina**, *P.B.* *Linseed.*

The seeds of *L. usitatissimum*, cultivated in Britain.

Characters and Constituents.—Small, oval, pointed, flat, with acute edges, smooth, polished, brown externally, yellowish-white within, of a mucilaginous oily taste.

Linseed is composed of mucilage, or bassorin, oil, and albumin. The *mucilage* constitutes about 15 per cent. of the entire seed; it is wholly contained in the epidermic layer of the testa or envelope of the seed. It is soluble in cold or hot water, and when freed from mineral matters has the same composition as althea mucilage, viz., $C_{12}H_{20}O_{10}$. The aqueous solution is precipitated by alcohol, nitrate and chloride of mercury, and the acetates of lead. Boiling nitric acid converts it into mucic and oxalic acids. Alkalies convert it into gum (arabin). The *oil* forms about 30 per cent. of the seed, and is contained in the albumen and embryo. It is fully described as Oleum lini. The rest of the seed is composed of 25 per cent. of *albumin* or legumin and a little sugar, which make the cake from which the oil has been expressed so valuable a food for cattle. The mineral constituents amount to nearly 8 per cent.; they are chiefly contained in the testa or husk, and are composed of phosphates. The testa also contains a minute quantity of tannic acid. Starch is altogether absent from the ripe seed.

Action. Uses.—Topically, emollient and demulcent. It is used in the form of infusion and cataplasm.

2. **Oleum Lini**, *P.B.* *Linseed Oil, expressed without heat.*

The seeds contain about one-third their weight of fixed oil.

Characters.—It is viscid, yellow, with a faint odour and oleaginous taste.

The oil contained in the kernel of the seeds, and obtained from them by expression, may be either cold drawn, or, as usually obtained, after the seeds have been subjected to a heat of 200°. As in the case of castor oil, linseed oil is paler, with less odour and taste when prepared without heat.

The sp. gr. is 0·902. It remains liquid at 0°; is soluble in alcohol and in æther; and differs from olive, almond, rape, and colza oils in possessing the property of drying into a varnish on exposure to the air. It enjoys this property in common with poppy, walnut, and cod-liver oils. In drying, linseed oil increases from 10 to 12 per cent., and the process is greatly facilitated by boiling the oil with oxyde of lead. By saponification linseed oil is resolved into glycerin and *linoleic acid*, $C_{16}H_{28}O_2$. This, when exposed in thin layers to the air, gradually increases in weight, and is converted into a colourless resinoid substance, called by Mulder *oxylinoleic acid*, $C_{16}H_{26}O_5,H_2O$. At 212° it loses water, becomes of a blood-red colour, and forms *linoxyn*, $C_{32}H_{54}O_{11}$. Linseed oil becomes blood-red from the production of this substance when acted upon by acids and alkalies. When exposed to a high temperature for some hours the oil is converted into a dark tenacious mass, which, as it cools, may be drawn into threads. This substance, when mixed with lamp-black, constitutes *printers' ink*. If it be boiled for some hours with dilute nitric acid, it is converted into *artificial caoutchouc*.

Common linseed oil obtained by expression at a steam heat of 200°, by which means the seeds are made to yield about 5 per cent. more, is of a deep amber colour, and disagreeable odour and taste. The cold-drawn oil soon assumes the same characters.

Linseed oil is sometimes used for adulterating other oils. Its presence in olive oil may be detected by its solubility in alcohol, and the coloration by acids and alkalies. Calvert states that both linseed and hempseed oils turn green with sulphuric acid, sp. gr. 1·47, and that they may be distinguished by means of nitric acid of sp. gr. 1·18, which turns oil of hempseed green, but does not affect the colour of linseed oil.

Action. Uses.—Emollient and cathartic. Chiefly used externally. (See Linimentum calcis.)

Dose.—4 fluid drachms to 1 fluid ounce as cathartic.

3. **Infusum Lini**, *P.B.* *Infusion of Linseed.*

Preparation.—Infuse 160 grains of *linseed*, and 60 grains of *fresh liquorice root* sliced, in 10 fluid ounces of *boiling water*, in a covered vessel for four hours, and strain through calico.

A pleasant infusion may be formed by merely steeping ½ ounce of the seeds in a pint of boiling water, and rendering it more palatable by the addition of sugar and some aromatics, as mint, lemon peel, &c. The decoction is more suitable for fomentation and enemata, as it separates more of the oil, but is on this very account less agreeable for internal use.

Dose.—It may be taken *ad libitum* for cough, sore throat, laryngitis, and to sooth the mouth in fever.

Incompatibilities.—Alcohol and metallic salts.

4. **Farina Lini**, *P.B.* *Linseed Meal.*

The cake of linseed from which the oil has been pressed, reduced to powder. It is employed in the preparation of the following poultices:—Cataplasma lini., C. carbonis, C. conii, C. sinapis, and C. sodæ chloratæ.

5. **Cataplasma Lini**, *P.B.* *Linseed Poultice.*

Preparation.—Mix 4 ounces of *linseed meal* gradually with 10 ounces of *boiling water*, then add ½ ounce of *olive oil*, constantly stirring.

Here the oleaginous and mucilaginous materials being mixed up together, and the properties of the latter elicited by the hot water, an admirable mixture is produced for making an excellent and readily-made emollient poultice. (If powdered linseed is used the olive oil is unnecessary.)

The linseed meal sold in France has been found adulterated with some refuse oil seed powder, mixed frequently with a little bran, oatmeal, and almond powder, with the refuse of starch manufactories, and often some rancid oil.

Linum catharticum (Purging flax), is a small inconspicuous plant which grows plentifully on dry heaths throughout Britain. It has long enjoyed the reputation of a popular purgative, but is not now included in the Pharmacopœias.

POLYGALACEÆ, *Juss.* Milkworts.

These plants are allied to the Violaceæ and Leguminosæ, but they are quite distinct from both. The characteristics of the order are the following:—Pedicels with 3 bracts. Sepals 5 irregular, 2 often petaloid. Petals 3. The anterior (keel) often bearded. Stamens 3 or 4 and distinct, or 8 and monadelphous, anthers 1-celled. They are possessed of astringent and emetic properties. Like the Sapindaceæ, some of them have saponaceous qualities.

POLYGALA SENEGA, *Linn.* Senega.

E. *Racine de Polygala de Virginie.* G. *Senega Wurzel.*

This plant is a native of North America.

Characters.—A small perennial plant with a knotty woody *root*, from which ascend a few annual erect simple *stems* from 6 to 12 inches high, smooth, and occasionally tinged with red below. *Leaves* sessile, bright green above. *Flowers* in a terminal spike, small dingy white, completely resembling those of our *P. vulgaris*, except that the *keel* is beardless. *Capsule* elliptical, emarginate.—*Steph. and Church, Med. Bot.* plate 103.

The root of this plant was introduced into practice in 1735, by Dr Tennant of Virginia, who learnt from the Senagaroo Indians that they employed it as an antidote against the bite of the rattlesnake. It is chiefly collected in the north-western parts of the United States.

1. **Senegæ radix,** *P.B. Senega Root.*

The dried root from North America.

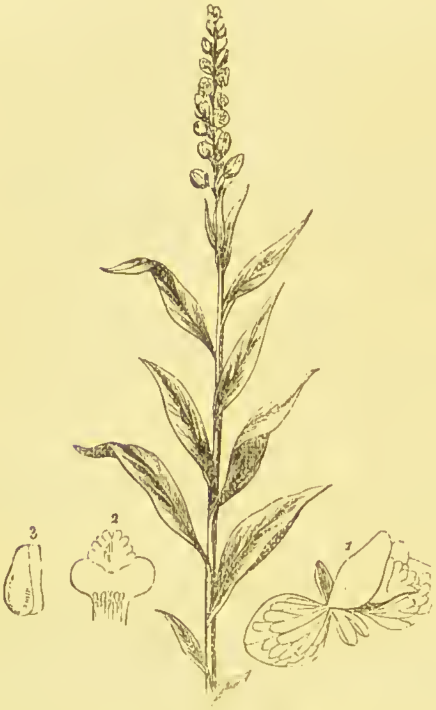


Fig. 124.—*Polygala Senega.* 1, flowers showing the two large-veined sepals; 2, beardless keel; 3, seed.

Characters and Constituents.—A knotty rootstock, with a branched taproot, of about the thickness of a quill, twisted and keeled by a cicatrix-like elevation, which is found in the convex side of the bends; bark yellowish-brown; odour sourish, and somewhat resembling scammony; the dust excites sneezing; taste sweetish, afterwards sourish and acrid, causing salivation; interior woody, tasteless, inert.

The root contains *senegin*, traces of *volatile oil*, *resin*, *gum*, *yellow colouring matter*, *malic acid*, and 7 per cent. of *sugar*. Senegin or polygalin is contained in the cortical part, which has a short fracture. According to Procter, the root yields 5½ per cent. of this substance. It is closely allied to saponin, exists as a white amorphous powder which is insoluble in cold water and in æther; it is soluble in alcohol and in boiling water, with which it forms a feebly acid frothy fluid, like a weak solution of soap. The taste is first sweet and then pungent, and somewhat numbing. It excites violent sneezing. It is decomposed by mineral acids and alkalies, both of which precipitate a jelly-like substance called *sapogenin*, and form sugar which remains in solution. With alkalies the solution assumes a glaucous tinge.

Substitutes.—The root of *Panax quinquefolium* (American Ginseng) is sometimes found in senega. It is a fine spindle-shaped root, and cannot be mistaken for senega.

Action. Uses.—Senega, as indicated by its acrid taste, is possessed of stimulant properties; it increases many of the secretions, acting as a sialogogue, expectorant, diaphoretic, diuretic, and emmenagogue; and in large doses it is emetic and cathartic. It is chiefly useful in chronic bronchitis.

Dose.—Of the powder 10 to 20 grains. But it is usually given in the following forms:—

2. **Infusum Senegæ,** *P.B.* *Infusion of Senega.*

Prepared by infusing ½ ounce of *senega root* bruised in 10 ounces of *boiling water* for an hour, and straining.

Dose.—1 to 2 fluid ounces.

3. **Tinctura Senegæ,** *P.B.* *Tincture of Senega.*

Prepared by exhausting 2½ ounces of *senega root* in coarse powder, with 1 pint of *proof spirit* as directed for Tinctura aconiti, and obtaining 1 pint of the tincture.

Dose.—½ to 2 fluid drachms.

KRAMERIA TRIANDRA, *Ruiz* and *Pavon*. Rhatany.

The Rhatany is a native of Peru, growing on the western slopes of the Cordilleras, especially near Huanuco and Lima, where it was discovered in 1779 by Ruiz, who found that the root was employed by the ladies for rubbing the teeth and strengthening the gums.

Characters.—A low woody shrub, with a greyish-silky foliage and red flowers; the *stem* is much branched, the branches procumbent, the younger portion covered with silky hairs, the roots horizontal, creeping. The *leaves* are sessile, oblong-ovate, pointed, and silky. The *flowers* are solitary, in the axils of the upper leaves, with short stalks. The *calyx* consists of 4 spreading sepals, silky externally, but smooth, shining, and lake-coloured internally, though not visible in dried specimens. *Petals* 5, unequal. *Stamens* 3, *anthers* opening by a double pore at the apex. The *fruit* is globular, leathery, indehiscent, about the size of a pea, covered with reddish-brown hooked prickles; one-celled, with one seed, the other being abortive. *Seed* inverse, suspended, without albumen.—*Fl. Peruv.* 1, t. 93; *Steph. and Church,* plate 72.

The dark-red root is the only part used in medicine. It is called *Peruvian* or *Payta Rhatany* and *Radix Ratanhiæ.*

1. **Krameriæ radix,** *P.B.* *Rhatany Root.*

The dried root, imported from Peru.

Characters and Constituents.—Dense, tough, and woody. About an inch in diameter; branches numerous, long, brownish-red, and rough externally; reddish-yellow internally, strongly astringent, tinging the saliva red. Some of the pieces are not so thick as the little finger, and as the loose rough cortex contains more of the active principle, these are to be preferred. The essential constituent, according to Wittstein, is *ratanhia-tannic acid,* an amorphous substance allied to catechu-tannic acid. It is almost exclusively contained in the bark, which yields 20 per cent. It does not precipitate tartar emetic, and is decomposed by dilute acids into *ratanhia-red* $C_{26}H_{22}O_{11}$, and sugar. The root does not contain gallic acid.

Varieties of Rhatany.—1. **Savanilla, or New Granada Rhatany,** the produce of *Krameria tomentosa.* This variety occurs in smaller pieces than the Peruvian, being only from 4 to 6 inches long, and usually less than ½ inch thick; it is also well distinguished by its dark-purplish colour and thick smooth bark, marked with longitudinal furrows, here and there with a deep transverse crack. Sections of Peruvian root turn grey when moistened with a protosalt of iron; those of Savanilla violet (D. Hanbury, *Pharmacographia,* p. 76).

2. **Parâ or Brazilian Rhatany.**—Resembles Savanilla, but has a darker tinge, and is more flexible. The bark is thick, and much cracked transversely.

3. **Chili Rhatany,** the produce of *K. cistoidea.* It is scarcely distinguishable from the Peruvian.

Incompatibilities.—Metallic salts, solutions of opium, morphia, and the cinchona alkaloids, gelatin, and the mineral acids.

Action and Uses.—Those of catechu. It is astringent and tonic. It is chiefly employed in mucous fluxes of the bowels and vagina. It is often serviceable in bronchorrhœa and cystitis. The powder is used in admixture with chalk, orris root, and myrrh, as a dentrifice. In this form, or as a wash, it is beneficial in irritable or congested conditions of the gums.

Dose of the powder, 10 to 30 grains. It is a constituent of Pulvis catechu compositus.

2. **Extractum Krameriæ,** *P.B. Extract of Rhatany.*

Preparation.—Macerate 1 pound of *rhatany root* in coarse powder in 1½ pint of water for twenty-four hours; then pack in a percolator, and add more water *until 12 pints have been collected,* or the rhatany is exhausted. Evaporate the liquor by a water bath to dryness.

The extract has a reddish-brown colour, and, when dry, a vitreous and shining fracture, and yields a blood-red powder, bearing a close resemblance to kino. That imported from South America used to be, and perhaps still is, employed for adulterating port wine.

Dose.—5 to 20 grains.

3. **Infusum Krameriæ,** *P.B. Infusion of Rhatany.*

Prepared by infusing ½ an ounce of *bruised rhatany root* in 10 fluid ounces of boiling water for an hour, and straining.

It is a deep reddish-brown fluid, of an astringent taste.

Dose.—1 to 2 fluid ounces.

4. **Tinctura Krameriæ,** *P.B. Tincture of Rhatany.*

Prepared by exhausting 2½ ounces of *rhatany root* in coarse powder, with 1 pint of *proof spirit,* in the manner prescribed for Tinctura aconiti, and obtaining 1 pint of the tincture.

Dose.—½ to 2 fluid drachms.

CANELLACEÆ, *Martius.*

CANELLA ALBA, *Murray.* White Canella.

The name Canella, a diminutive of Canna, was at one time applied to the cinnamon, whence its French name Canella. When the present plant was discovered in South America, it was supposed to be the true cinnamon, and called by its then name. The earliest full, though not the first account, was given by Monardes (*Clus. Exot.* p. 323), who states that in 1540 an expedition was sent by Pizarro to examine the province Cumaco, where this cinnamon was said to be found. It was long confounded with Winter's bark, and at one time called *Winterania canella* and *spurious Winter's bark*, though both had been clearly distinguished by Sir Hans Sloane in *Phil. Trans.* 1692.

Canella alba is a tree which is common in many parts of the West India Islands and in South America, frequently on the sea-coasts, where it seldom exceeds twelve or fifteen feet, but in the inland forests it attains a more considerable height. It is propagated chiefly by wild pigeons, who feed on its berries. The tree has a straight stem and branched top, and a good deal resembles the Pimento.

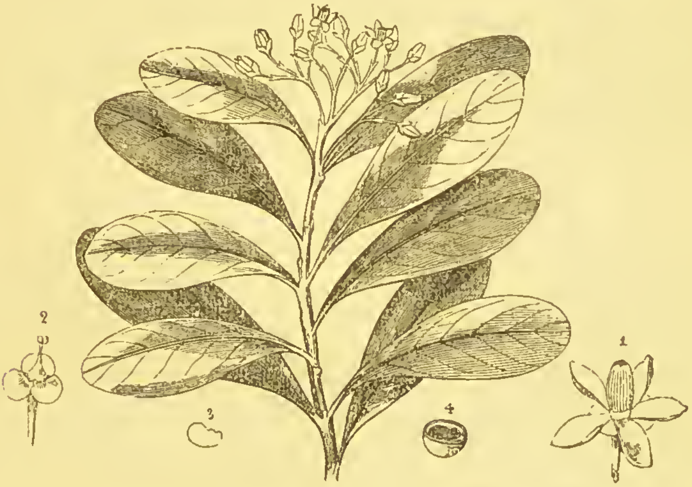


Fig. 125.—*Canella alba.* 1, flower; 2, pistil and sepals; 3, seed; 4, fruit.

Characters.—The *bark* is whitish, so that the tree is at once distinguished from others. The *leaves* are alternate, obovate, entire, the younger ones pellucido-punctate; the older smooth, shining, exstipulate, coriaceous, without nerves. The *flowers* are in terminal corymbs, small, and of a violet colour, but seldom open. *Sepals* 3, imbricate, roundish. *Petals* 5, hypogynous, oblong, twisted in æstivation. *Stamens* united into a subcylindrical tube. *Anthers* 21, linear, fixed longitudinally on the outside of the tube. *Ovary* free, 3-celled. *Style* cylindrical. *Stigma* 2-lobed. *Berry* by abortion 1 or 2-celled; cells 2-3 seeded; *seeds* one above the other, kidney-shaped, beaked, black, and shining. *Embryo* within fleshy albumen in the beak of the seed, curved, and roundish; cotyledons linear.—*Sloane, Jam.* ii. t. 191, f. 2; *Swartz, Linn. Trans.* i. vol. viii.; fructif. *Gærtner,* i. 373, t. 77.

1. **Canellæ albæ Cortex,** *P.B. Canella-alba Bark.*

It is imported from the West Indies. The bark is removed from the tree with an iron instrument, and is then deprived of its epidermis and dried in the shade.

Characters and Constituents.—In quills or broken pieces, hard, of a yellowish-white or pale clove-like odour and an acrid peppery taste. The essential constituent is a *volatile oil,* about 0·9 per cent. of which may be obtained by distillation of the bark with water; it is of a reddish colour, acrid to the taste, and of a fragrant odour. It resembles cajuput and oil of cloves in some of its physical characters and chemical relations, smelling remotely like a mixture of the oils of cloves and cajuput, and containing both eugenic acid and cajuputol—the essential constituents of these oils. Water extracts a little of the aromatic oil, a *bitterish extract,* and a little *mannite,* which was described by Petroz and Robinet as canellin; also a little *starch* and *gum.* When incinerated the bark yields 6 per cent. of ash, chiefly composed of *carbonate of lime.*

The bark is completely free from tannic and gallic acids, so that the infusion is not darkened by the salts of iron. It is thus distinguished from Winter's bark (see *Drimys Winteri*).

Action and Uses.—An aromatic stimulant, and as such may be used as an adjunct to tonic and purgative preparations. It is employed as a condiment by the West Indian negroes.

Dose.—10 to 30 grains of the powder.

Pharmaceutical Use.—A constituent of Vinum rhei.

VIOLACEÆ, *Juss.* The Violet Family.

The botanical characters and medicinal properties of these plants are well illustrated in the violet. Persistent sepals, 5 crested introrse anthers, and a tricarpellary capsular fruit with 3 parietal placentæ, are the salient characteristics of the order. Several of the shrubby species of Ionidium (see Martius' *Spec. Mat. Med. Braziliensis*) are employed as substitutes for ipecauanha. The roots of *Ionidium ipecacuanha* are the *false Ipecacuanha of Brazil;* they yielded Pelletier 5 per cent. of emetia. Cuchunchully de Cuença, the roots of *Ionidium microphyllum,* have similar properties.

VIOLA ODORATA, *Linn.* Sweet Violet.

This, the ἴον of the Greeks, is found wild on the borders of fields, in shady situations in many parts of Europe, but is cultivated on account of its flowers, which are so much esteemed for their agreeable odour and colour.

Characters.—A perennial, stemless plant. *Leaves* cordate, nearly smooth; petioles with deflexed hairs. *Bracts* above the middle of the flower stalk. *Sepals* obtuse. *Flowers* purple or white, scented.—*Eng. Bot.* ii. pl. 329 (619).

The *recent petals* are the parts employed. The flowers should be gathered soon after they have blown. The colour may be retained for some time if they are carefully dried, but for a still longer period if preserved in syrup. As the violet or purple colour is changed into red by acids, and green by alkalies, it is often employed as a test.

Action. Uses.—The expressed juice and the syrup are slightly laxative; and hence, besides being employed on account of its odour and colour, the syrup is prescribed as a laxative for young, especially new-born children, with an equal quantity of almond oil, in doses of one or two tea-spoonfuls.

Boullay separated a yellowish, bitterish, amorphous alkaloid from the root, which he called *violine*. It resembles, and is probably identical with, emetine; and this plant, as well as other species, especially *V. tricolor*, have also been employed as demulcent expectorants on the Continent. The seeds and roots are stated to be purgative and emetic.

Syrupus Violæ. *Syrup of Violets.*

Preparation.—Macerate 10 ounces of *fresh violet petals* in 1 pint of *water* for twelve hours; then press, strain and filter. Add 3 pounds of *sugar*, and dissolve by the aid of a gentle heat, and when cool add 3 fluid ounces of *rectified spirit*.

This syrup has a light-blue colour, an agreeable taste, and an odour of the flower; sp. gr. 1·33. It is frequently imitated. Syrup of pansies is substituted for it. Indigo in powder, sulphate of indigo, the red cabbage, and the red poppy are employed to imitate it. Out of 12 samples purchased and examined by Mr Kendall, not one was genuine (*Phar. Journ.* xiii. 19).

MENISPERMACEÆ, *Decand.* Moonworts.

The plants belonging to this order are tropical climbing shrubs distantly related to *Aceraceæ* and *Sapindaceæ*. The medullary plates of the woody stems form coarse radiating plates separating the wedges of wood which are composed of coarse longitudinal fibres, and large hollow ducts, visible to the naked eye (illustrated in the structure of Pareira root). The flowers are insignificant, and usually diœcious. (See *Cissampelos* and *Cocculus.*) The fruit is usually a fleshy drupe, containing a single seed, which is more or less curved by the extraordinary growth of the placenta (see the seed of *Cocculus Indicus*).

The properties of the order are fully illustrated in the following plants, *Cissampelos Pareira* (tonic, diuretic), *Cocculus palmatus* (bitter tonic), and *Anamirta cocculus* (poisonous narcotic).

CISSAMPELOS PAREIRA, *Linn.* Velvet Leaf or Pareira Brava.

This is a climbing shrub indigenous in Brazil, where it is called *Pareira brava* (or wild vine), and in some of the West India Islands.

Characters.—*Stem* round, smooth, downy. *Leaves* roundish subcordate, smooth above, covered with silky pubescence below. *Inflorescence* in branched racemes, pubescent. *Male flowers*—*Sepals* 4. *Petals* 4, minute, united into a cup-shaped corolla. *Stamens* monadelphous, with the 2-celled anthers opening horizontally at the top. *Female flowers—Racemes* simple, floral envelopes, of a single lateral sepal and petal. *Ovary* solitary. *Stigmas* 3. *Drupe* hispid, scarlet, reniform. *Seed* uncinate. *Embryo* roundish, enclosed in fleshy albumin.

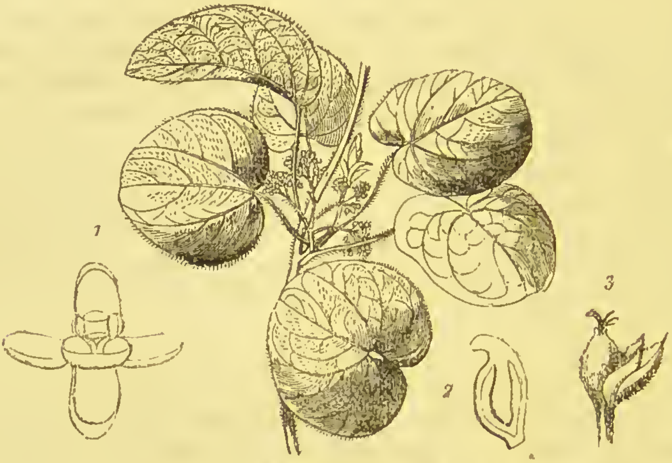


Fig. 126.—*Cissampelos Pareira.* Male plant.
1, male flower; 3, female flower; 2, ovary in vertical section.

The root of this plant was first made known by Marcgraf and Piso in their works, *Hist. Nat.* and *Hist. Rer. Nat.* 1648, by the name of *Caapeba;* the Portuguese called it *Erva de nossa Senhora,*

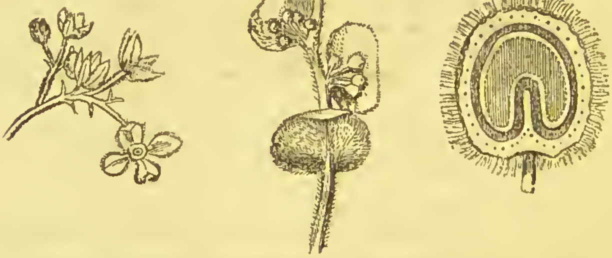


Fig. 127.—*Cissampelos Pareira.* Female plant.
1, female flower; 2, male flower; 3, fruit in vertical section.

and Ray mentions it in 1688, as "contra calculum excellentissima est." The root, and also the stem, not only of this, but of other species, are employed. Aublet states that the roots of *Abuta rufes-*

cens pass for and are employed as White Pareira in Cayenne, and that a variety of the same yields Red Pareira. Auguste St Hilaire gives *Cissampelos glaberrima* as yielding the original Pareira of Brazil, where Martius states it is called *Capeba* and *Sipo de Cobras.*

Mr D. Hanbury (*Pharmacographia*, p. 28) adduces evidence which is almost conclusive, that the drug exported from Rio de Janeiro, the source of supply to this country, is the produce of the *Chondodendron tomentosum.* This plant, which has a great resemblance to *Cissampelos Pareira*, grows abundantly in Peru and Brazil, and in the immediate neighbourhood of Rio. It is readily known from Cissampelos by the fruit, which resembles a small bunch of black grapes, the individual drupes being ¾ths of an inch long, oval, and black. This striking feature of the "wild vine" (*Pareira brava*) is wanting in Cissampelos. Mr H. further states that the wood of the Jamaica plant does not present the form of concentric rings, and is invested by a thickish corky bark.

1. **Pareiræ radix,** *P.B. Pareira Root.*

The dried root of *Cissampelos Pareira*, from Brazil.

Characters.—Cylindrical, oval, or compressed pieces, entire or split longitudinally, half an inch to four inches in diameter, and four inches to four feet in length. Bark greyish-brown, longitudinally wrinkled, crossed transversely by annular incomplete concentric ring elevations; interior woody, yellowish-grey, porous, with well-marked incomplete concentric rings, and medullary rays. Taste at first sweetish and aromatic, afterwards intensely bitter.

This dried root contains about 4½ per cent. of an amorphous alkaloid, *cissampelia* or *pelosia*, $C_{18}H_{21}NO_3$, some resin and nitrate of potash. Cissampelia has a sweetish bitter taste, is insoluble in water, both hot and cold, but under certain circumstances forms a trihydrate which becomes yellow on exposure. It forms bitter salts with the acids, and dissolves freely in alcohol and æther. Flückiger states that it has the chemical characters of Beberia (see p. 461) and Buxina (*op. cit.* p. 27), there inadvertently called berberia.

Action and Uses.—It would appear that the active principle is eliminated by the kidneys, and exercises a slightly stimulant action in this gland, increasing the quantity of urine; and that its subsequent passage over the genito-urinary mucous membrane has a tonic influence upon its blood-vessels, for it is found to be beneficial in chronic diseases of this membrane, as in gonorrhœa and cystitis.

Dose.—Of the powdered root from 20 to 60 grains. It is usually given in one of the following forms :—

2. **Decoctum Pareiræ,** *P.B. Decoction of Pareira.*

Preparation.—Boil 1½ ounce of *sliced Pareira root* in 1 pint of *water* for fifteen minutes, and strain. Wash the residue with a little water, in order to make the product measure a pint.

Dose.—1 to 3 ounces as a mild tonic and demulcent diuretic.

3. **Extractum Pareiræ,** *P.B.* *Extract of Pareira.*

Preparation.—Digest 1 pound of *Pareira root in coarse powder* with 1 pint of boiling *water* for twenty-four hours, then pack in a percolator, and adding more boiling water, allow the liquor slowly to pass until a gallon has been collected, or the Pareira is exhausted. Evaporate the liquor by a water bath until the extract has acquired a suitable consistence for forming pills.

Dose.—10 to 20 grains.

4. **Extractum Pareiræ liquidum,** *P.B.* *Liquid Extract of Pareira.*

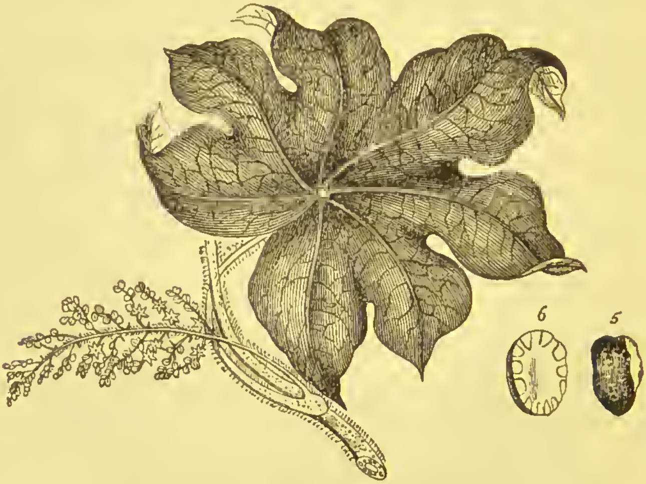
Preparation.—Obtain a gallon of aqueous infusion by exhausting a pound of *Pareira* in the manner directed for the extract. Evaporate this by a water bath to 13 fluid ounces, and when it is cold add 3 fluid ounces of *rectified spirit*, and filter.

Each fluid ounce of this preparation corresponds to 1 ounce of the root.

Dose.—½ to 4 fluid drachms.

JATEORHIZA PALMATA, *Miers.* Calumba.

This plant, the *Cocculus palmatus* of Decandolle, is indigenous to the forests of Eastern Africa, between Ibo and Oibo and the banks of the Zambesi, where it climbs to the tops of the loftiest trees.



Fig, 128.—*Jateorhiza palmata.* 6, section of stem; 5, seed.

Characters.—A lofty herbaceous climber, having a perennial *root* composed of a bundle of several fleshy spindle-shaped tubers, brown externally and deep yellow internally, devoid of smell, but very bitter. The *stems* are annual, herbaceous, and twining, covered with glandular hair. *Leaves* alternate, nearly orbicular, cordate at the base, 5–7 lobed, lobes entire, wavy on the surface and margin, acuminate, hairy with long petioles. *Racemes* axillary. *Flowers* small, diœcious, green. *Calyx* of 6 sepals in two series with bracteoles. *Petals* 6, obovate, half enclosing the 6 opposite stamens. *Anthers* terminal, 2-celled, dehiscing vertically. *Ovaries* 3, united at the base. *Drupes* or berries about the size of a hazel-nut, densely clothed with long-spreading hairs, tipped with a black oblong gland.—*Sir W. Hooker, Bot. Mag.* t. 2970–71; *Steph. and Church*, pl. 160.

The root of this plant was introduced as a medicinal agent by F. Redi about the year 1677. The roots are dug up in March, then sliced and dried in the shade. Semedus mentioned it before 1722 among drugs from India. In works on Materia Medica in use in India it occurs by the name of *Kalumb.* Dr Berry first ascertained that it was the root of a plant (of which he figured the male) inhabiting the forests on the coast of Mozambique and Oibo in Eastern Africa, but where it is never cultivated.

1. **Calumbæ radix**, *P.B. Calumba Root.*

The root cut transversely and dried. From the forests of Eastern Africa between Ibo and the Zambesi.

Characters and Constituents.—Slices flat, circular or oval, about two inches in diameter, and from two to four lines thick, softer and thinner towards the centre, greyish-yellow, bitter. A decoction when cold is blackened by solution of iodine (showing the presence of starch, the blue coloration being very intense).

Its bitter tonic properties are due to three distinct but related principles,—calumbin, berberia, and calumbic acid. Böedeker has pointed out that calumbin *plus* a molecule of ammonia, contains the elements of berberia, calumbic acid, and 3 atoms of water. *Calumbin* ($C_{21}H_{22}O_7$) is the principal constituent; it is a neutral substance, intensely bitter, crystallising in colourless rhombic prisms, but slightly soluble in water, alcohol, or æther, unless aided by heat. It is freely soluble in solutions of the alkalies and in dilute acetic acid. *Berberia* ($C_{20}H_{17}NO_4$) is an alkaloid found abundantly in the common barberry (*Berberis vulgaris*), whence its name. It is also very bitter: it occurs in yellow odourless prisms; heated to 212° it becomes red, but resumes its yellow colour on cooling. It forms with alcohol a solution which is yellow by transmitted and green by reflected light, and is precipitated by the addition of water, in which it is but slightly soluble. It forms yellow soluble salts with vegetable acids. In calumba root it is combined with calumbic acid, and imbues it with its yellow colour. *Calumbic acid* ($C_{22}H_{24}O_7$) is a yellow amorphous substance, and like the other principles is but feebly soluble in cold water. Calumba root also contains a little *resinous extract*, a trace of *volatile oil*, and one-third of its weight of *starch.* It is completely free from both tannic and gallic acids, as indicated by the absence of reaction with solutions of perchloride of iron and of gelatin.

When good, calumba root is of a bright colour, breaks easily, and furnishes a greenish-yellow powder.

Calumba root is sometimes adulterated with American or false calumba, of which the infusion becomes dark green with the sesquichloride of iron. A considerable quantity of an article called *calumba wood* was imported from Ceylon about two years since. It displays the peculiar structure of a menispermaceous stem. The true calumba plant does not grow in Ceylon; and it appears that this wood is the product of the *Menispermum fenestratum*, Gærtn., *Coscinium* of Colebrook, said by Ainslie to be in common use as a tonic among the Cingalese. It contains the alkaloid berberia.

Action. Uses.—Stomachic and mild tonic.

Dose of the powder, 10 to 30 grains.

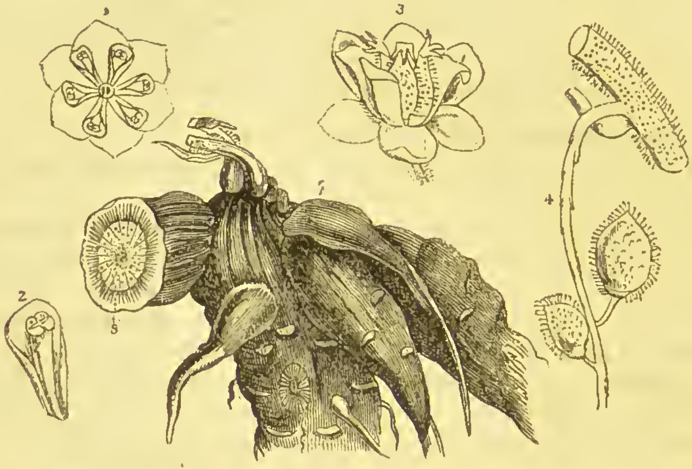


Fig. 129.—*Jateorhiza calumba.* 1, Male flower; 2, petal, enclosing the opposite stamen; 3, female flower; 4, the hairy drupes; 7, the root; 8, do. transverse section.

1. **Extractum Calumbæ,** *P.B.* *Extract of Calumba.*

Preparation.—Macerate 1 pound of *calumba root*, cut small, with 2 pints of *water* for twelve hours, strain and press. Macerate again with the same quantity of water, strain and press as before. Mix and filter the liquors, and evaporate them by the heat of a water bath until the extract is of a suitable consistence for forming pills.

Dose.—5 to 10 grains.

2. **Infusum Calumbæ,** *P.B.* *Infusion of Calumba.*

Preparation.—Macerate in a covered vessel ½ an ounce of *calumba root*, cut small, in 10 fluid ounces of *cold water* for one hour, and strain. It soon undergoes decomposition. If made with hot water it contains an abundance of starch, and if prescribed with iodine will form a dark-blue mixture. But cold water takes up albumin, which is coagulated by hot water, so that the infusion made with it soon turns mouldy.

Dose.—1 to 2 ounces twice or thrice a day.

3. **Tinctura Calumbæ,** *P.B.* *Tincture of Calumba.*

Preparation.—Take of *calumba root* cut small 2½ ounces, *proof spirit* 1 pint, and prepare as Tinctura aconiti.

Dose.—1 to 2 drachms, as an adjunct to bitter draughts and mixtures.

ANAMIRTA COCCULUS, *Wight and Arnott.* Cocculus Indicus.

This plant, the *Menispermum cocculus* of Linnæus, is common in the mountainous parts of the Malabar coast, whence our supplies of the fruit, and they are large, are now all derived through Bombay, Madras, and Ceylon. All but a very small quantity is reshipped to the Continent. Formerly these berries reached Europe by the Red Sea and the Mediterranean, whence they were called *Grana Orientis* by Ruellius, 1536, *Coque du Levant* by Pomet, &c. There is no proof, though it is probable, that they were known to the Arabs. The *mahizuhra* (fish poison) of Rhases, Serapion, and Avicenna, and referred by Sprengel to these berries, seems to have been a plant and its bark, "Qua juvat in doloribus juncturatarum et contortione digitorum" (Serapion). Plempius coined the name *ichthyoctonum* to indicate "fish-poison." The plant yielding these berries was ascertained by Dr Roxburgh. Dr Royle thinks the Latin term *cocculus* (a little berry) is probably derived from the Tamul *kakacollis*, which signifies, as does the Sanscrit *kakmare*, *crow-killing*.

Characters.—A fine woody *climber*, with ash-coloured, deeply cracked, corky bark. *Leaves* large, broadly ovate, somewhat cordate at the base, acute at the apex, with 5 digitate ribs, petioles a little shorter than the leaves, tumid at both ends. *Flowers* diœcious, in lateral compound racemes. *Calyx* of 6 sepals in a double series with 2 close-pressed bracteoles. *Corolla* none. ♂ *Stamens* united into a central column dilated at the apex; *anthers* numerous, covering the whole globose apex of the column. ♀ *Flowers* unknown. *Drupes* 1–3, 1-celled, 1-seeded. *Seed* globose, deeply excavated at the hilum. *Albumin* fleshy; *cotyledons* very thin, diverging, and each occupying a side of the hollow cavity that contains the embryo.—*Wallich, Asiatic Res.* vol. xiii. pls. 15 and 16.

1. Fructus cocculi.

The so-called cocculus "berries" are the only parts of the plant used. They are the dried purple drupes, and are of the size of a large pea, and roundly kidney-shaped, composed of a thin woody shell, covered externally with a dark brown wrinkled skin, and containing the solitary seed which should occupy the whole of the interior. If a vertical section be made through the hilum the seed will be seen seated upon, and everywhere enveloping the spherical placenta, which appears to be the upward prolongation and termination of the fruit stalk, resembling 3, fig. 127. The seed is oily and very bitter. The woody shell is destitute of active properties, and, according to Combe and Pelletier, contains two crystallisable, tasteless substances of identical composition,—menispermine and paramenispermine. The oily bitter seed contains half its weight of stearin, and from $\frac{1}{3}$ to 1 per cent. of *picrotoxin*, $C_5H_6O_2$ (πικρὸς, bitter; τοξικὸν, poison), to which the fruit owes its activity. It is a neutral substance, probably a glucoside, crystallises in colourless needles, sometimes in silky filaments, in plates, and in rhombic prisms. It is intensely bitter; is soluble in 150 parts of water at 57°, and in 25 of boiling water, in 2 of æther, and in about 3 parts of alcohol. It is insoluble in both the fixed and the volatile oils.

It does not combine with acids, though soluble in acetic acid; and as it forms combinations with alkalies, it is considered by some to be of the nature of an acid. To obtain it, Sir R. Christison first separates the oil from the kernels by expression, next exhausts them by percolation with rectified spirit, which is then to be distilled off. The residue is agitated with boiling water, acidulated with hydrochloric acid. The dissolved picrotoxine may be obtained on cooling after moderate concentration.

Action. Uses.—Cocculus fruit is narcotic and convellent, producing giddiness, tetanic convulsions, and coma. It has been used for taking fish and game, and by unprincipled brewers for adulterating porter. For this purpose it is recommended by Childe and by Maurice in their books "on Brewing"! It is used chiefly in the form of a bitter extract, known by the name of *black extract*, which is ostensibly prepared for tanners. (See *Cycl. of Pract. Receipts.*) Applied externally as an ointment, it is employed to destroy pediculi, and for the cure of scabies, ringworm, and porrigo.

2. **Unguentum Cocculi.** *Ointment of Cocculus Indicus.*

Prepared by mixing 80 grains of the *seeds* separated from the husk and powdered, or 10 grains of *picrotoxin* with 1 ounce of *prepared lard.*

VITACEÆ, *Juss.* The Vine Family.

These plants, also called Ampelideæ, from ἄμπελος, a vine, are common in the tropics, especially of Asia. The familiar vine may, in both botanical characters and medicinal properties, be taken as the type of the order.

VITIS VINIFERA, *Linn.* The Grape-Vine.

The vine was early cultivated in Egypt, Palestine, and Greece. It is probably a native of Persia. It is found wild about Tinkaboon in Deilum, about N. lat. 37°, on the southern shores of the Caspian (Royle, *Him.* p. 146). Humboldt also states that it grows wild on the coasts of the Caspian Sea, in Armenia, and in Caramania.

Like other cultivated plants, it varies much in growth and in the quality of its fruit. It sometimes attains a great size, climbing to the tops of the highest trees in Italy and in Cashmere, and sometimes lives for three or four hundred years.

Characters.—*Leaves* lobed and sinuato-dentate, naked or tomentose. *Calyx* obscurely 5-toothed. *Corolla* composed of 5 petals, cohering at the apex, and like a calyptra splitting at the base and falling off together. *Stamens* 5. *Style* wanting. *Berry* 2-celled, 4-seeded, cells and seeds often abortive. The great diversity in form has been summed up by De Candolle in the following words:—"The leaves are more or less lobed, smooth, pubescent or downy, flat or curled, pale or deep green. Branches prostrate, climbing or erect, tender or firm. Bunches loose or crowded, ovate or cylindrical; the berries red, greenish, or white, watery or fleshy, globose, ovate, or oblong, sweet, musky, or austere. Seeds often varying in number, or fruit seedless."—*Woodv. Med. Bot.* pl. 195.

Of the grape-vine there are numerous varieties cultivated in different countries, as well as in the hot-houses of England. When unripe the fruit is remarkable for the harsh acidity of its juice, which is then called *verjuice.* It owes this property to free citric, oxalic, and tartaric acids, and to the acid tartrate of potash. It also contains tannin and extractive, sulphates of potash and of lime, also malate and phosphate of lime. This juice was employed in medicine, and is still used for making syrups and sherbets.

Grapes as they ripen lose their acid taste, becoming sweet and delicious in flavour. They are wholesome both to the sick and to those in health; allaying thirst in febrile affections, and being pleasant nutritious articles of diet. The agreeable acidity is due to the acid tartrate of potash, and to small quantities of undecomposed citric and malic acids. The sweetness is due to grape sugar or *glucose* (see p. 322). When grape-juice undergoes fermentation, this sugar is converted into alcohol and carbonic acid, and the acid tartrates of potash and lime are slowly deposited (see p. 323). Grape-juice also contains *gum, extractive, colouring matter,* and a *glutinoid* substance, the presence of which readily excites fermentation. This juice, when expressed, is called *must* (mustum or new wine).

Uses.—The grape yields by fermentation the various kinds of wine, French or Cognac brandy (p. 327, *et. seq.*), wine-vinegar, and the acid tartrate of potash, from which tartaric acid is obtained. Also the following:—

Uvæ, *P.B.* *Raisins.* F. *Raisins.* G. *Rosinen.*

The ripe fruit of the grape-vine, dried in the sun or with artificial heat. Imported from Spain.

Constituents.—The pulp of the resin consists chiefly of *glucose, gum, acid tartrate of potash,* and *malic acid.* The sugar and cream of tartar form nodules of crystalline matter in old raisins. The seeds yield from 15 to 18 per cent. of a tasteless fixed oil, and about the same quantity of tannic acid. The skin also contains tannic acid and colouring matter.

Varieties.—Valencia raisins are usually employed in pharmacy. *Dessert, Malaga,* or *Muscatel* raisins are dried on the vine by partially cutting the main stalk of the branches before the fruit is quite ripe. *Sultana* raisins, like the *Bedanas* of the East, are stoneless. *Corinthian* raisins, commonly called "currants," are the produce of a small-sized grape which is abundant in the Ionian islands.

Uses.—Besides their dietetical uses, raisins are demulcent, and furnish an agreeable flavour to tinctures and beverages. They are ingredients of Tinctura cardamomi composita and Tinctura sennæ.

ACIDUM TARTARICUM, *P.B.* Tartaric Acid.

$$2HO,C_8H_4O_{10} = 150 \text{ or } \mathbf{H_2C_4H_4O_6} = 150.$$

Tartaric acid—the acid of tartar—was discovered by Scheele in 1770. It is contained in the juice of the grape, tamarind, and other acidulous fruits. *Tartar* or *argol* is deposited from grape juice in the process of fermentation, in proportion as the alcohol is formed, being insoluble in spirit. It is an impure acid tartrate of potash, and when purified forms ordinary cream of tartar (see p. 140). This is the source of tartaric acid, which is separated by the following process:—

Preparation.—Boil 45 ounces of *acid tartrate of potash* with 2 gallons of *water*, and add gradually 12½ ounces of prepared *chalk*, constantly stirring. When the effervescence has ceased, add 13½ ounces of *chloride of calcium*, dissolved in 2 pints of *water*. When the tartrate of lime has subsided pour off the liquid, and wash the tartrate with water until it is rendered tasteless. Pour 13 fluid ounces of *sulphuric acid*, first diluted with 3 pints of water, on the tartrate of lime, mix thoroughly, boil for half an hour, with repeated stirring, and filter through calico. Evaporate the filtrate at a gentle heat until it acquires the sp. gr. of 1·21, allow it to cool, and then separate and reject the crystals of sulphate of lime which have formed. Again evaporate the clear liquor till a film forms on its surface, and allow it to cool and crystallise. Lastly, purify the crystals by solution, filtration (if necessary), and recrystallisation. This process usually requires to be repeated with the use of animal charcoal, in order to obtain a perfectly colourless salt.

The first step in the above process consists in the formation of a neutral tartrate of potash and tartrate of lime, with the evolution of carbonic anhydride and the formation of water, thus:— $2KHC_4H_4O_6 + CaCO_3 = K_2C_4H_4O_6 + CaC_4H_4O_6 + CO_2 + H_2O$, two molecules of the acid tartrate of potash, reacting upon one of carbonate lime; tartrate of lime is precipitated, and neutral tartrate of potash remains in solution. On the addition of the calcic chloride the latter is decomposed, more tartrate of lime is precipitated, and chloride of potassium remains in the solution, thus:—

$$K_2C_4H_4O_6 + CaCl_2 = CaC_4H_4O_6 + KCl.$$

The whole of the tartaric acid is thus precipitated in combination with lime. Then, the washed tartrate of lime formed in the two decompositions is decomposed by sulphuric acid, and the solution of free tartaric acid containing a little excess of sulphuric acid is separated from the insoluble sulphate of lime. The presence of a little excess of sulphuric acid favours the crystallisation of the tartaric acid.

Character and Tests.—In permanent colourless crystals, the primary form of which is the oblique rhombic prism. It has a strongly acid taste, and is readily soluble in water (in 5 or 6 parts at 60°, and 2 parts at 212°) and in rectified spirit. When to either solution, not too much diluted, a little acetate of potash is added, a white crystalline precipitate (acid tartrate of potash) is formed. 75 grains of the crystallised acid dissolved in water require for neutralisation 1000 grain-measures of the volumetric solution of soda. An aqueous solution of the acid is not affected by sulphuretted hydrogen (absence of metallic impurity), and gives no precipitate with the solution of sulphate of lime or of oxalate of ammonia (both of which indicate the absence of lime). It leaves no residue, or only a mere trace, when burned with free access of air.

An aqueous solution of tartaric acid becomes mouldy, and is slowly converted into one of *acetic acid.* The relation of tartaric acid to other vegetable acids is interesting. It is illustrated in the following reaction, and in the changes which it undergoes on exposure to heat. When heated with the caustic alkalies *oxalic* and *acetic acids* are formed, which take the place of the water in the base, thus:—
$H_2C_4H_4O_6 + 3KHO = K_2C_2O_4 + KC_2H_3O_2 + 3H_2O$.
Boiled with nitric acid, it is converted into *oxalic acid,* and when boiled with dioxyde of lead it is resolved into formic and carbonic acids, which unite with the base. In all these reactions it agrees with citric acid. Tartaric acid is converted into *succinic acid* ($H_2C_4H_4O_4$) by heating it with hydriodic acid for a few hours. Heated below 338°, tartaric acid is converted into the modifications known as *meta-* and *para-tartaric acids.* Above 370° tartaric acid fuses, two atoms of the acid lose one of water, and are thus converted into *tartralic* or *ditartaric acid.* At 374° the basic water is completely expelled, and *tartaric anhydride* remains as a white porous mass, soluble in water, alcohol, or æther. By the gradual absorption of water it returns to ordinary tartaric acid. By destructive distillation tartaric acid yields acetic, pyruvic, formic, and pyrotartaric acids, aldehyd, and carbonic anhydride. Pyruvic acid $(C_6H_8O_6) + 2H_2 = 2$ molecules of lactic acid ($C_3H_6O_3$), and this conversion may be effected by heating it with hydriodic acid.

TARTRATES.—Tartaric acid is dibasic, and decomposes the carbonates. It has a strong tendency to form double salts (see Soda tartarata $KNaC_4H_4O_6,4H_2O$; Ferrum tartaratum $K,FeO,C_4H_4O_6,H_2O$; and tartarated antimony $KSbO,C_4H_4O_6,H_2O$). A soluble tartrate is readily detected, when the solution is moderately concentrated, by the addition of potassic acetate, a few drops of acetic acid being previously added if the solution be neutral. On briskly stirring, the sparingly soluble acid tartrate of potash is precipitated. A solution of calcic sulphate is not precipitated by tartaric acid. Lime water in excess gives a precipitate which is soluble in solution of potash and ammonic chloride. Salts of silver give a sparingly soluble precipitate of argentic tartrate. Calcic chloride and plumbic acetate cause white precipitates in solutions of the neutral tartrates. Tartaric acid added to solutions of the salts of iron or copper prevent the precipitation of the oxydes of these by ammonia (see pp. 219, 236), which property it shares with citric acid.

Incompatibilities.—See the preceding paragraph.

Action and Uses.—Antalkaline and refrigerant; in large doses it is an irritant, causing gastro-enteritis. It is almost always given in the form of an effervescing neutral, or alkaline solution, with carbonate of potash, carbonate of soda, or carbonate of ammonia (see pp. 154, 165); 20 grains of tartaric acid are neutralised by 15½ of carbonate of ammonia, 22 of bicarbonate of soda, and 27 of bicarbonate of potash.

Substitute.—Bisulphate of soda has been fraudulently sold, under the name of "Common tartaric acid," for use in the gazogene apparatus.

Pharmaceutical Uses.—In the preparation of the following salts: —Antimonium tartaratum, Ferrum tartaratum, Potassæ tartras, P. t. acida, Sodæ citro-tartras effervescens, Soda tartarata.

CRUCIFERÆ, *Jussieu.* The Cabbage Family.

The Cruciferæ or Brassicaceæ are distinguished from the Papaveraceæ by the absence of narcotic properties, the 4 sepals, the definite tetradynamous stamens, and the exalbuminous seeds. The two orders approach each other closely through the siliquous fruited Poppyworts, Glaucium, Chelidonium, &c. The genus Sinapis may be taken as the type of the order, both botanically and medicinally.

COCHLEARIA ARMORACIA, *Linn.* Horse Radish.

F. *Cran de Bretange.* G. *Meerrettig.*

This plant is regarded by some as the *wild radish* of Dioscorides, and the *Armoracea* of Pliny. It seems to have been clearly recognised by Brunsfels in 1530. It is a native of most hilly situations in Europe, and is much cultivated in this country, flowering in May.

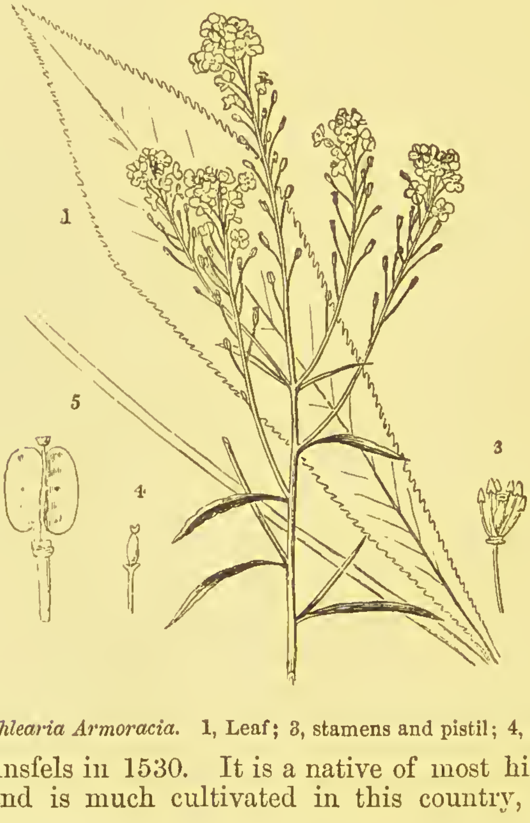


Fig 130.—*Cochlearia Armoracia.* 1, Leaf; 3, stamens and pistil; 4, pistil; 5, fruit.

Characters.—The large oblong *leaves* of this plant are familiar objects in every garden. From their midst arise in early summer a few annual flowering *stems*, furrowed, bearing a few scattered acutely-serrated sessile leaves, and terminating in 3 or 4 long *racemes* of small white flowers. The *calyx* is spreading, equal at the base; the *silicle* ovate, with very convex valves, without a dorsal vein.—*Woodv. Med. Bot.* pl. 150.

1. **Armoraciæ radix,** *P.B.* *Horse Radish Root.*

The fresh root of *Cochlearia Armoracia*, cultivated in Britain.

Characters and Constituents.—A long, cylindrical, fleshy root, ½ to 1 inch in diameter, expanding at the crown into several short shoots. It is white both externally and internally. It has a pungent taste, and emits when crushed or scraped a strong odour of mustard.

The alcoholic extract is odourless, but the characteristic emanation is at once developed by the addition of a solution of myrosin or that which contains it, an emulsion of white mustard. When distilled with water it yields oil of mustard (p. 736). It is evident, therefore, that it contains both *myronate of potash* or *sinigrin* and *myrosin*, by the mutual action of which its pungency is developed (see p. 735). The fresh root yields about 0·2 per cent. of *volatile oil of mustard.* Besides the above constituents it contains a little fat and sugar. Tannic and gallic acids are both absent.

The presence of sulphur in the root is indicated by the addition of salts of silver or lead to the aqueous solution, a precipitate of black sulphide being formed in either case.

Action and Uses.—Stimulant, rubefacient, diuretic, and diaphoretic. As a stomachic stimulant it has been taken with hard salted meats by the inhabitants of Central and Northern Europe for many ages. Mustard supplants it as an external application, but it is more suitable than mustard as a diuretic. The following preparation is a feeble representative of the drug.

2. **Spiritus Armoraciæ compositus,** *P.B.* *Compound Spirit of Horse Radish.*

Preparation.—Mix 20 ounces each of *horse radish root scraped* and *bitter orange peel*, cut small and bruised, ½ ounce of *bruised nutmeg*, 1 gallon of *proof spirit* and 2 pints of *water*, and distil a gallon with a moderate heat.

This process is defective. The whole of the oil of mustard is not developed in the process of scraping, and the scraped root should therefore be infused in the cold water for twenty-four hours before the spirit (which coagulates and makes the myrosin inert, see p. 735) is added. By this means a more active preparation would be formed.

Dose.—1 to 2 fluid drachms as a stimulant diuretic and diaphoretic. It is a good addition to other diuretics, such as Decoctum scoparii.

SINAPIS NIGRA, *Linn.* Black Mustard.

This and the following plant are indigenous annuals, cultivated in rich alluvial soils, chiefly in Durham and Yorkshire, for the sake of their seeds. They have been long used in medicine, being the Νάπυ or Σινηπι of Dioscorides, and the Sinapi of the Romans.

Characters.—*Stem* 2–4 feet high, hispid below, with smooth round branches above. Lower *leaves* rough, lyrate, with the large lobe cut or toothed; upper linear-lanceolate, dependent. *Flowers* yellow. *Calyx* spreading. *Siliqua* small, erect, adpressed, obtusely quadrangular, smooth, terminated by a short quadrangular beak. *Seeds* 4 to 6, spherical, dark brown, but often blotched with white, cuticle minutely but irregularly pitted.—*Eng. Bot.* pl. 969.

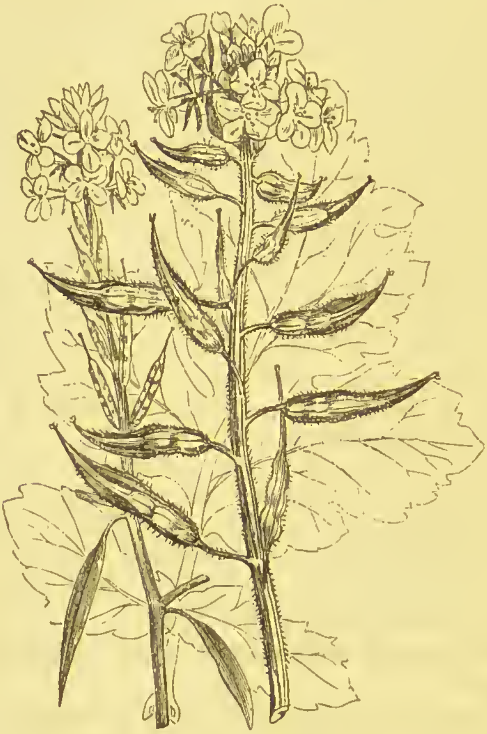


Fig. 131.—*Sinapis nigra. Sinapis alba.*

SINAPIS ALBA, *Linn.* White Mustard.

Characters.—*Stem* 1–2 feet high, round, smooth, or only slightly hairy. *Leaves* lyrate, pinnatifid, roughish. *Flowers* yellow, larger than those of *S. nigra. Siliqua* hispid, spreading on nearly horizontal stalks, shorter than those of *S. nigra,* and, like them, exalbuminous, and composed of an *embryo,* the radicle of which is folded upon the surface of one of the *cotyledons,* which are themselves folded together so as to enclose it; and of a *testa,* which in this plant is quite even.—*Eng. Bot.* pl. 1677.

1. **Sinapis,** *P.B. Mustard.*

The seeds of *Sinapis nigra* and *Sinapis alba;* also the mixed seeds reduced to powder.

Characters and Constituents of the Powder.—Greenish-yellow, of an acrid bitterish oily pungent taste; odourless when dry, but exhaling when moist a pungent, penetrating, peculiar odour, very irritating to the nostrils and eyes. A decoction, when cold, is not coloured blue by tincture of iodine (absence of starch).

This test is a necessary one, for mustard is commonly adulterated with flour, turmeric, and capsicum powder, the latter two articles being added to imitate the natural colour and pungency.

Ripe mustard seeds are free from starch; they contain about 23 per cent. of *fixed oil*, yellowish, free from taste and odour, non-drying, and chiefly composed of olein; about 20 per cent. of *mucilage;* about 10 per cent. of *myrosin* in black mustard, and 15 per cent. in white. So far the constituents are common to both black and white mustard seed; the remainder indicate a slight difference. The characteristic constituent of black mustard is myronate of potassium, or *sinigrin;* that of white mustard *sinalbin.* They are obtained from the seeds after expression of the fixed oil by means of boiling alcohol, from which they separate in a crystalline form. Both substances are decomposed by an aqueous solution of myrosin, so that mustard and water has properties totally different from those of the dry powder. The composition and reactions of sinigrin will be considered under oil of mustard; those of sinalbin, the constituent of white mustard, are as follows:—*Sinalbin* separates from hot alcohol in colourless crystals; it is readily soluble in cold water. The solution, in contact with one of myrosin, is decomposed; it becomes acid from the formation of sulphate of sinapin, turbid from the separation of albumin and the formation of an acrid volatile oil—*sulphocyanate of acrinyl*, and sweet from the presence of *glucose.* Myrosin itself is an albuminous ferment, resembling diastase and emulsin or synaptase. It is readily soluble in cold or warm water, is coagulated and becomes inert at 140°, and by the addition of alcohol, the mineral acids, or strong solutions of the vegetable acids; carbonate of potash also checks its fermentative action. The reaction of myrosin on sinalbin is thus indicated by Will:—

$$\underset{\text{Sinalbin.}}{C_{30}H_{44}N_2S_2O_{16}} = \underset{\text{Sulphocyanate of Acrinyl.}}{C_8H_7NSO} + \underset{\text{Sulphate of Sinapin.}}{C_{16}H_{25}NSO_9} + \underset{\text{Glucose.}}{C_6H_{12}O_6}.$$

Sulphocyanate of acrinyl is to white mustard what oil of mustard is to black; it is the pungent, odorous, irritating principle; it is an acrid volatile oil, insoluble in water, soluble in alcohol and æther. Caustic potash decomposes it with the production of sulphocyanide of potassium. Sinapin is an unstable alkaloid; its salts are readily decomposed by caustic potash, with the production of a brilliant yellow colour.

A consideration of the reactions of myronate of potash, given below, will show its close relationship to sinalbin.

Action and Uses.—The bland fixed oil, obtained by expression of mustard seeds, has been used as a mild purgative. Mustard itself is a local stimulant and rubefacient, and a stimulant diuretic. As a *stimulant* in atonic dyspepsia, the young herb or the whole seeds may be taken; but the ordinary mustard paste is preferable to the latter. As a *stimulant emetic* in narcotic poisoning, when the sensibility of the mucous membrane of the stomach is greatly blunted, mustard is the most reliable emetic we possess. As a *stimulant diuretic*, mustard sometimes proves serviceable in passive dropsy. As a local stimulant and rubefacient it is a good adjunct to stimulant embrocations or the foot-bath.

Dose.—As a stomachic, from 5 to 20 grains; as an emetic, from a teaspoonful to a tablespoonful in warm water; as a diuretic, it may be given in the form of infusion (2 ounces of the seed to 1 pint of warm water or milk), 2 ounces to be taken twice or thrice a day.

2. **Oleum Sinapis,** *P.B.* *Oil of Mustard.*

The oil distilled with water from the seeds of black mustard, *Sinapis nigra*, Linn., after the expression of the fixed oil.

It will be inferred from what has been already said of the constituents of mustard seeds, that this, the essential product of black mustard seed, does not pre-exist in the seed, being formed by the action of myrosin on myronate of potash or sinigrin. According to Will and Körner, the latter separates into sulphocyanide of allyl or oil of mustard, hydropotassic sulphate, and glucose, thus:—

$$\underset{\text{Sinigrin.}}{C_{10}H_{18}KNS_2O_{10}} = \underset{\text{Oil of Mustard.}}{C_4H_5NS} + KHSO_4 + \underset{\text{Glucose.}}{C_6H_{12}O_6},$$

the reaction corresponding exactly with that of myrosin on sinalbin. That this oil does not pre-exist in the black mustard seed is obvious from the fact that the dried powder is odourless, that it is only developed on the addition of water, which, by dissolving both the sinigrin and myrosin, brings them into contact; that if the sinigrin be removed by boiling alcohol, or if the myrosin be rendered inert by throwing the mustard into boiling water, or previously heating it above 140°, no oil of mustard is developed. Ludwig and Lange isolated sinigrin in the form of colourless brilliant needles, having a bitter cooling taste. It exists in the seed in the proportion of about 2½ per cent. The yield of oil is about ½ per cent.

Characters.—Colourless or pale yellow; sp. gr. 1·015. Dissolves readily in alcohol, æther, and to a slight extent in water. Has an intensely penetrating odour, and a very acrid, burning taste. Applied to the skin it produces almost instant vesication.

This oil is apt to contain a large proportion of cyanide of allyl, C_4H_5N, the result of a further action of myrosin on the sulphocyanide. Since its sp. gr. is only 0·839, its presence may be inferred when the density of the oil of mustard is less than that given above.

The chemistry of oil of mustard is extremely interesting; thus when heated for a few hours in a sealed tube with bipotassic sulphide, it is converted into oil of garlic and potassic sulphocyanide; it combines directly with ammonia to form a compound called *thiosinnamine*, which has the properties of an organic base, corresponding to the urea of the allyl series.

Use.—The oil is used in the following preparation:—

3. **Linimentum Sinapis compositum,** *P.B.* *Compound Liniment of Mustard.*

Preparation.—Dissolve 40 grains of *æthereal extract of mezereon* and 120 grains of *camphor* in 4 fluid ounces of *rectified spirit*, and add 1 fluid drachm of *oil of mustard* and 5 fluid ounces of *castor oil.*

Action and Use.—As a liniment it is stimulant, but when applied to the skin by means of a piece of lint covered with gutta percha tissue, it is a strong rubefacient. As a liniment it is useful for chronic rheumatic pain, chronic spasm, chilblains, &c.; as a rubefacient it may be used instead of mustard poultice.

4. **Cataplasma Sinapis,** *P.B.* *Mustard Poultice.*

Preparation.—Mix 2½ ounces of *linseed meal* gradually with ½ pint of *boiling water*, and add 2½ ounces of *mustard* in powder.

If the linseed meal and mustard have a temperature of 60°, the mean temperature of the mixture will be 160°, sufficient to coagulate the myrosin and render the mustard inert. The mixture must, therefore, be made in a cool vessel by which the temperature will be reduced below 140°, when oil of mustard will be developed.

Use.—A powerful rubefacient and counter-irritant in inflammatory affections of the internal organs, or in neuralgic disorders of the muscles or fibrous tissue. As a counter-irritant it may be applied to the feet, legs, or nape; thus used, it is a prompt and valuable aid in the treatment of apoplexy, and for the relief of coma and narcotism. As a nervine stimulant it may be applied to the cardiac region to arouse the action of the heart. It is more painful and less efficacious than a blister, but it is usually free from the inconveniences attending abrasion of the skin, although the tender and painful erythema which follows its use is often very great. In persons of feeble circulation, and in whom the senses are blunted, care must be taken lest too long contact with the skin should produce vesication, which in this condition may result in ulceration and even sloughing. Such a poultice as the above can rarely be borne longer than half an hour, and a more beneficial, because a more prolonged action may be obtained by using mustard in the proportion of 1 part to 6 or 8 of linseed meal, for this may be retained in contact with the surface for seven or eight hours without discomfort.

5. **Charta Sinapis,** *P.B.* *Mustard Paper.*

Preparation.—Mix 1 ounce of *black mustard seeds* in powder with 2 fluid ounces or a sufficiency of *solution of gutta-percha* so as to form a semifluid mixture. Pour this into a dish and pass pieces of cartridge paper over its surface, so that one side of the paper shall receive a thin coating of the mixture. Then lay the paper on a table, with the coated side upwards, and allow it to dry.

Dose.—When applied to the skin, after immersion for a few seconds in tepid water to develop the oil of mustard, it forms an extemporaneous mustard plaster. It is a most convenient and very cleanly substitute for the foregoing poultice.

PAPAVERACEÆ, *Jussieu.* The Poppy Family.

These plants are related, through Podophyllum, to the Berberidaceæ, and through Platystemon to the Ranunculaceæ. Through the siliquose fruited genera, Chelidonium and Glaucium, it approaches the Cruciferæ. Many species abound in a milky juice which is narcotic. The genus Papaver is the type of the order, both botanically and medicinally. The following are its characters:—*Herbaceous* plants with a milky juice. *Peduncles* 1-flowered, naked, drooping before the expansion of the flower. *Sepals* 2, convex, deciduous. *Petals* 4, crumpled in æstivation. *Stamens* numerous. *Stigmas* 4 to 20, radiating, sessile upon the disk which crowns the ovary. *Capsule* obovate, 1-celled, composed of 4 to 20 carpels united together, and opening by small valves beneath the crown formed by the stigmas. *Placentæ* opposite the stigmas, produced internally into spurious, incomplete dissepiments. *Seeds* numerous, reniform. *Embryo* minute, at the base of oily albumin.

PAPAVER RHŒAS, *Linn.* The Red or Corn Poppy.

The common red or corn poppy is found in corn-fields and on roadsides throughout Europe, and has probably been introduced with wheat. This species, or *P. dubium*, with its oblong capsules, is probably the *ῥοίας* of the Greeks.

Characters.—The *root* is fibrous, the *stem* many-flowered, and, like the peduncles, rough, with spreading hairs. *Leaves* pinnatifid, with oblong, jagged, toothed lobes. *Petals* scarlet, often nearly black at the base. *Capsule* obovate, rounded at the base, smooth, with the margin of the 8 to 10 stigmas incumbent. The flowers expand in June and July.—*Woodv. Med. Bot.* plate 186.

The petals of this plant are the only parts used in medicine.

1. **Rhœados petala,** *P.B. Red Poppy Petals.*

The fresh petals of the plant above described, from indigenous plants.

Characters and Constituents.—Of a scarlet colour, and heavy poppy odour. The petals consist of 12 per cent. of yellow *fatty matter*, 20 of *gum*, 28 of *lignin*, and 40 of *red colouring matter* (Riffard). According to L. Meier, the red colouring matter consists of two amorphous acids, *rhœdic* and *papaveric.* The colouring matter is freely soluble in water and alcohol, but is insoluble in æther. The aqueous solution is blackened by alkalies, and rendered dirty violet by solution of persalts of iron. The foregoing constituents have no appreciable hypnotic action; and Attfield failed to separate from the petals any trace of morphia. It is possible, however, that one or more of the narcotic principles of opium may exist in them in minute quantity and in an amorphous condition. The milky juice of the unripe capsule is decidedly narcotic. Hesse obtained from the plant a feebly alkaline substance which he has called *rhœadine* ($C_{21}H_{21}NO_6$). It is crystallisable, colourless, tasteless, inert, and is soluble to any extent in acids only. The solution in dilute sulphuric or hydrochloric acids becomes, after a time, of a permanent rich red colour. Alkalies discharge but do not destroy the colour.

2. **Syrupus Rhœados,** *P.B.* *Syrup of Red Poppy.*

Preparation.—Add 13 ounces of fresh *red poppy petals* gradually to 1 pint of *water*, heated in a water bath, frequently stirring them; then, the vessel being removed, infuse for twelve hours; afterwards press out the liquor, strain, add 2¼ pounds of *refined sugar*, and dissolve by means of heat. When nearly cold, add 2½ fluid ounces of *rectified spirit*, and make up for the loss with water, so that the product shall weigh 3 pounds 10 ounces, and have sp. gr. 1·33.

Action.—Chemistry, it is true, fails to detect any hypnotic principle in the petals of the red poppy, but there is a more delicate test than chemistry—the nervous system of an infant, and on this it has a manifest sedative influence.

Dose.—1 fluid drachm.

PAPAVER SOMNIFERUM, *Linn.* The White Poppy.

This plant appears to have been cultivated very early, as Homer is thought to allude to it as growing in gardens. Hippocrates mentions two kinds, the *black* and *white poppy*, so the Arabs and Persians distinguish the *khuskhash abiuz* or white, from the *khuskhash aswad*, or black poppy. The white poppy is now culti-

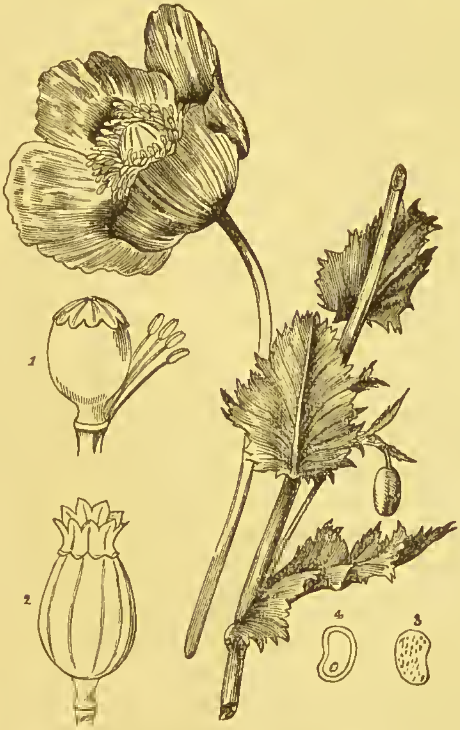


Fig. 132.—*Papaver somniferum.*

1, pistil, with a few stamens; 2, the unripe capsule; 3, seed; 4, section of seed.

vated in the plains of India, and the black, or deep-red variety, in the Himalayan mountains.* It was early cultivated, as it still is, in Egypt, also in India, Persia, Asia Minor, as well as in some parts of Europe.

The garden poppy is probably a native of Persia. It has, however, been so long grown in gardens in various parts, that it is sometimes found apparently wild, especially in the southern parts of Europe.

Characters.—An annual plant from 2-4 feet high. *Stem* round and straight, glaucous, smooth, with a few hairs towards the white and tapering extremity and on the peduncles. *Leaves* large, sessile, amplexicaul, smooth, of a glaucous green, margins wavy, cut and toothed. *Flowers* large and terminal, drooping before expansion, with smooth concave sepals; 4 large *petals*, roundish, white or purplish, with a darker-coloured spot near the claws. *Capsule* nearly globose, large, smooth, with parietal placentæ equal in number to the stigmas, which are covered with numerous white or brownish coloured kidney-shaped *seeds*. Flowers in June and July, and the capsules ripen about two months later.—*Woodv. Med. Bot.* plate 185.

There are three distinct varieties of this plant; α *album*—larger and less glaucous, with white petals and seeds, capsules ovate, indehiscent; β *nigrum*, flowers violet or red, seeds black, capsules globose, opening by foramina under the stigmas; γ *setigerum*, the wild form, the incisions of the leaf each terminating in a bristle.

1. **Papaveris capsulæ**, *P.B.*

The nearly ripe dried capsules, cultivated in Britain.

Characters and Constituents.—Globular, 2 or 3 inches in diameter, crowned by a sessile stellate stigma.

Proper attention should be paid to the direction that the capsules be collected *when nearly ripe*, for the perfectly ripe, dry capsule is almost completely free from the active constituents of opium, whereas the unripe capsule contains an appreciable amount of morphia. This accounts for the discrepancy in the results of analysis by different chemists, some (Merck and Winckler) finding as much as 2 per cent., and others not a trace. Groves found *codeia*, and Deschamps d'Avallon *meconic*, *citric*, and *tartaric acid*, and two crystalline bodies, *capsule-papaverin* and *papaverosin*, neither of which exist in opium. Hesse also found *rhœadin* (see p. 738).

The French find the capsules from the Levant or the southern provinces of France to be more powerful than those grown in the north. The seeds (*maw* seeds) contain much fixed oil, which possesses the property of drying like linseed oil.

Action and Uses.—Slightly hypnotic. The capsules are employed in the following preparations, and in all but the first they are directed to be used after the seed has been separated.

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* Mr Hamilton says—"The opium is chiefly obtained from the single white poppy; I have also seen the red and purple colours, though only one is usually seen in a field. I hardly remember to have noticed any mixture of colour in one piece of ground. The kind here cultivated generally grows to a height of 3 feet."—Hamilton, *Travels in Asia Minor*, ii. p. 115.

2. **Decoctum Papaveris**, *P.B.* *Decoction of Poppies.*

Preparation.—Boil 2 ounces of *poppy capsules* bruised in 1½ pint of water for ten minutes in a covered vessel; strain; add *water* till the product measures 1 pint.

Action. Uses.—A demulcent anodyne fomentation, applied to swollen, painful, and inflamed parts, as the eye, abdomen, joints, &c.

3. **Syrupus Papaveris**, *P.B.* *Syrup of Poppies.*

Preparation.—Mix 36 ounces of *poppy capsules*, bruised and freed from seed, with 4 pints of *water*, and infuse for twenty-four hours, frequently stirring, then pack them in a percolator, and exhaust the capsules by the repeated addition of more boiling water. Evaporate the liquor (about 2 gallons) by a water bath to 3 pints. When cold, add 16 ounces of *rectified spirit;* let the mixture stand for twelve hours, and filter. Distil off the spirit, evaporate the remaining liquor to 2 pints, and then add 4 pounds of *refined sugar.* The product should weigh 6½ pounds, and have the sp. gr. 1·320.

The spirit precipitates mucilage and albumin, and is itself subsequently removed by evaporation. When made without spirit the syrup is very fermentable.

This is an excellent anodyne and narcotic syrup, when carefully prepared; but it is sometimes improperly made with extract of poppies and syrup, or with laudanum and treacle, forming mixtures which vary much, and are dangerous to infant life.

Dose.—1 to 4 drachms for adults, and 10 to 15 minims for infants.

4. **Extractum Papaveris**, *P.B.* *Extract of Poppies.*

Preparation.—Exhaust 1 pound of *poppy capsules, dried, freed from the seeds*, and coarsely powdered, with *boiling water* in the manner prescribed for the preparation of Syrupus papaveris, and obtain about 1 gallon of fluid. Evaporate this by a water bath until it is reduced to a pint, and when cold add 4 ounces of *rectified spirit.* Let the mixture stand for twenty-four hours, then separate the clear liquor by filtration, and evaporate it by a water bath until the extract has acquired a suitable consistence for forming pills.

This extract has long been known, being the *meconion* of the ancient Greeks. It is a good substitute for opium in many cases, allaying pain and inducing sleep, without, it is thought, producing nausea, or the irritability often caused by opium.

Dose.—2 to 3 grains, as a gentle anodyne and hypnotic.

5. **Opium**, *P.B.* *Opium.*

The juice (Ὀπὸς, *the* juice pre-eminently) inspissated by spontaneous evaporation, obtained by incision from the unripe capsules of the poppy, *Papaver somniferum*, Linn., grown in Asia Minor.

Opium, obtained by making incisions into the unripe capsules of the poppy, and allowing the juice to concrete, seems to have been known from early times. Hippocrates is supposed to have employed it, and Diagoras condemned its use in affections of the eyes and in earache. Dioscorides describes it; but opium does not appear to have been much employed until the time of the Arabs, except in the form of the confections called Mithridatica, Theriaca, and Philonium. The Arabic name *afioon*, the Hindu *aphim*, and the name *afooyung*, by which it is known in China, must all have proceeded from the original Greek name, which is itself derived from ὀπός, juice. The Sanscrit *apaynum* seems to have a similar origin.

Preparation.—Opium is obtained by making incisions in the evening into the capsules of the poppy, shortly after the petals fall off, taking care not to penetrate into the interior.* In Asia Minor the incision is made around the capsule about the middle, or carried in a spiral line from below upwards. In India the capsule is scarified vertically from apex to base, and the operation repeated, at intervals of a few days, sometimes as many as six times. A milky juice exudes, and either concretes upon the capsule, whence it may be taken off in little tear-like masses, or earlier in the morning in a softer state. Upon this it will depend whether the grains run together, or remain separate even when pressed. When thus collected the opium is dried in a warm and airy room, when it becomes of a brown colour, with a shining fracture, and has a strong and peculiar odour. Some opium which Dr Royle prepared in this manner in the Saharanpoor Botanic Garden in 1828–29, was pronounced by the Medical Board of Bengal to be like Turkey opium. Most of the opium made in the Himalayan mountains is similarly prepared, and is of very fine quality. Belon and Olivier describe the opium of Asia Minor as formed by the assemblage of the small tears collected off the capsules. Dioscorides describes the process as consisting in making incisions into the capsules when the dew has evaporated, collecting the juice in a shell, mixing the several portions, and rubbing them up in a mortar. Kempfer gives this as the Persian process, and M. Texier describes it as being adopted in Asia Minor; and it is certainly practised with the immense quantities collected in India in the provinces of Behar and Benares, and of which an excellent description has been given by Dr Butter in the Journal of the Asiatic Society, p. 136. When this method is adopted the mass will appear homogeneous; when it is omitted it will appear to be composed of agglutinated tears. Both appearances may be observed in the opium of commerce.

Characters.—Irregular lumps weighing from 4 ounces to 2 pounds; enveloped in the remains of poppy leaves, and generally covered with the chaffy fruits of a species of rumex; when fresh, plastic, tearing with an irregular, slightly moist, chestnut-brown surface, shining when rubbed smooth with the finger, having a peculiar odour and bitter taste.

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* In 1844 M. Aubergier made some experiments on the cultivation of the opium-poppy in France. He found that opium obtained from the long poppy-heads yielded more morphia than that which flowed from the round ones. That after the 1st of July, or after the capsule began to turn yellow, the percentage of morphia in the opium diminished. He states that the object of not making the incision quite through the pericarp is that after so doing the seeds are lost. They do not ripen, and no oil can be obtained from them. The preparation of this oil is an important source of profit.

Test.—Break down 100 grains of opium, and steep it in 1 ounce of water for twenty-four hours, stirring the mixture frequently. Transfer it to a displacement apparatus, and exhaust by percolation with 3 ounces more of water. To the fluid thus obtained, placed in a flask, add 100 grains of slaked lime, to precipitate the meconic acid and liberate the morphia; boil for ten minutes, transfer to a filter, and wash the undissolved matter with 1 ounce of boiling water. Acidulate the filtered fluid slightly with diluted hydrochloric acid, evaporate it to ½ an ounce, and let it cool. Neutralise cautiously with solution of ammonia, carefully avoiding an excess; remove by filtration the brown matter which separates, and wash it with 1 ounce of hot water. Mix the washings with the filtrate, concentrate the whole to ½ an ounce, and now add ammonia in slight excess. After twenty-fours, collect the precipitated morphia on a weighed filter, wash it with cold water, and dry it at 212°. It ought to weigh at least from 6 to 8 grains.

Constituents.—Several analyses were made of opium before any just ideas were obtained respecting its constitution. Derosne in 1803 first obtained a saline body. Sertürner and Seguin both discovered in 1804 another crystallisable substance, upon which subsequent experience has proved the narcotic power of opium to depend. In a second memoir of Sertürner, published in 1817, he announced his discovery of *morphia* combined with *meconic acid.* Since then opium has been found to consist of a great variety of principles, some of which are bases and some are neutral bodies. Many of these, however, are produced by the processes employed for the separation of the natural constituents. The following will serve to indicate the primary and chief secondary or derivative constituents of opium:—

Primary Constituents.

Morphia (*μορφεὺς*), $C_{17}H_{19}NO_3$, H_2O, 6 to 12 per cent.
Codeia (*κώδεία*, a poppy-head), $C_{18}H_{21}NO_3$.
Thebaia, (Thebes), $C_{19}H_{21}NO_3$.
Narceia (*νάρκη*, stupor), $C_{23}H_{29}NO_9$.
Papaverine, $C_{21}H_{21}NO_4$. } less than 1 per cent.
Narcotine (*ναρκωτικός*), $C_{22}H_{23}NO_7$.
Meconic acid, $H_3C_7HO_7$, $3H_2O$. } 6 to 8 per cent.
Meconine or *Opianyl* (*μήκων*, a poppy), $C_{10}H_{10}O_4$, a trace.
Rhœadine, $C_{21}H_{21}NO_6$, a trace.
Resinous matter.
Caoutchouc, 4 to 5 per cent.
Essential oil.
Gum or *mucilage.*

Secondary Constituents.

Apomorphia, $C_{17}H_{17}NO_2$.
Apocodeia, $C_{18}H_{19}NO_2$.
Codamina, $C_{20}H_{25}NO_4$.
Cotarnia, $C_{12}H_{13}NO_3$.
Hydrocotarnia, $C_{12}H_{15}NO_3$.
Cryptopia (*κρυπτω*, to hide, and *ὀπος*), $C_{23}H_{25}NO_5$.
Meconidia, $C_{21}H_{23}NO_4$.
Laudanosia, $C_{21}H_{27}NO_4$.
Protopia, $C_{20}H_{19}NO_5$.
Rhœadine.
Meconine or *Opianyl.*
Lanthopine, $C_{23}H_{25}NO_4$.
Lactic or *Thebolactic acid.*

Adulterations.—Mucilaginous and albuminous matters, probably a little sugar, and scrapings of the poppy capsule, are the natural and unavoidable constituents of opium, and make up about half the weight of soft opium. Various articles, such as sand, clay, sugar, molasses, starch, gum-arabic, cow dung, and pounded poppy seeds are employed to increase its weight and bulk. But the most subtle adulteration is opium from which the morphia has been extracted. A proper proportion of solid matter, obtained by drying at 212°; of morphia by the above test; of ash, about 7 per cent. and the absence of reactions of an aqueous solution with solutions of iodine, gelatin, and of alcohol (which precipitates gum acacia), indicate the purity of the drug. Good opium is of a dark-brown or blackish colour externally and of a reddish-brown internally, is either homogeneous or formed of agglutinated tears; sp. gr. about 3·36; the taste strongly and permanently bitter, with a rather pleasant flavour and heavy aroma. It should contain not more than 15 per cent. of water, and yield 50 per cent. of aqueous extract. When kept in a dry place it becomes hard, and even brittle, breaking with a compact, shining fracture, and producing a yellowish-brown powder. Warm or cold water dissolves about two-thirds and rectified spirit four-fifths of the whole, forming reddish-brown solutions containing all the constituents of the drug. Æther dissolves much of what is left by water. The dilute acids also remove the active constituents. From these solutions the alkalies precipitate the active principles, but redissolve them when added in excess. Tannic acid, the tannates, carbonates and bicarbonates, and some metallic salts also precipitate the alkaloids.

Incompatibilities.—Alkalies precipitate the opium alkaloids, but redissolve them more or less in an excess. They are also precipitated by lime and magnesia and their salts, and by tannic acid. As some of these are apt to be prescribed with opium, it is essential to attend to the form of exhibition, for the precipitate may contain all the active principles, and the solution be inert; or it may be made active again by using an excess of ammonia or potash; or the active principle may be taken up by the acid of some of the salts used. But these various effects of reagents can be duly appreciated only when the composition of opium is understood.

Varieties of Opium.—The opiums known in European commerce have been described under the following heads by Guibourt. That collected in Asia Minor, chiefly in Anatolia, is generally all included under the head of Turkey opium, and most of it is exported from Smyrna; some of it, however, is taken to Constantinople, whence it is re-exported to other parts of Europe. Some Egyptian is imported into this country. The Persian is scarcely known. The Indian kinds are exported to China.

1. **Smyrna Opium**—*Levant*, *Turkey*, or *Constantinople opium*—is generally in flattened masses, and, in consequence of its original softness, without any definite regular form; these masses weighing

from a half to two pounds, and covered with the remains of a poppy leaf and capsules of a species of rumex. It is at first soft, of a distinct brown colour, becoming blackish and hard when dried, losing weight from evaporation of water, and having the strong and peculiar odour of opium. When examined with a magnifier, it is seen to be composed of yellowish agglutinated tears. This is the purest kind of opium, yielding about 8 per cent. of morphia and 4 per cent. of narcotine, and on an average about 12 per cent. of hydrochlorate of morphia. It is that indicated in the Pharmacopœia.

Smyrna opium is produced at several places, at from ten to thirty days' distance in the interior; but that grown at Caisar, about 600 miles from Smyrna, is the most esteemed for its cleanness and good quality. Mr Hamilton states that much is produced at Bogaditza; it is made into lumps about 4 or 5 inches in diameter, and closely invested by leaves.

According to M. Landerer, Smyrna opium is prepared in the interior of Asia Minor, chiefly in Kara Chissar (Caisar), and near Magnesia. It is a compound product. The tears obtained by incisions into the capsules are allowed to flow into small shells, and dried in the sun. This opium, which is of the best quality, is mixed with an extract prepared by boiling down the fresh leaves of the poppy plant. The mass is then divided into cakes. These are wrapped in fresh poppy leaves and placed on shelves to dry. It is thought advantageous that, while drying, they should be exposed to the morning and evening dews. The same writer states, that it is not uncommon for Smyrna opium to be adulterated with salep-powder, in order to harden it. This causes the tincture to assume a slimy or mucilaginous consistence (*Pharm. Journ.* x. 474). For an interesting account of the production of Smyrna opium, by Mr Maltass, see *Pharm. Journ.* xiv. 395.

2. **Egyptian Opium** is in flattened roundish cakes about 3 inches in diameter, and covered with the remains of some leaf which M. Guibourt was unable to distinguish. It appears good externally, is homogeneous, inclines to a reddish hue, is not blackened by keeping, but softens on exposure to the air, and has somewhat of a musty smell. It is generally inferior, and M. Guibourt obtained only $\frac{5}{7}$ of the morphia yielded by Smyrna opium.

Some opium has been collected in Algiers. A new variety imported from Turkey has been described by Mr Morson (*Pharm. Journ.* iv. 503). It resembles the Constantinople, but was soft and light-coloured; contained much wax, caoutchouc, and about $6\frac{1}{2}$ per cent. of morphia.

3. **Persian Opium**, which Dr Pereira calls Trebizond opium, from his specimens having been obtained from thence. The specimens in the King's College Museum were sent by Mr Morson, to whom M. Guibourt was also indebted. This kind is of a black colour, apparently homogeneous in texture, and in sticks some inches in length, each wrapped up in a separate piece of paper, and tied with a piece of cotton.

4. **Indian Opium** is not known in European commerce. The *Saharunpore garden opium*, first cultivated by Dr Royle, is of a brown colour, shining fracture, with the strong and peculiar odour of opium, and yielded the late Professor Daniell, in one of the last analyses he made, 8 per cent. of morphia. The *Himalayan opium* possesses similar sensible properties, and though liable to be adulterated, is, when pure, of very fine quality. The *Malwa opium* is in flat circular cakes, average weight 1½ lb., of a rusty-brown colour, strong odour, and bitter permanent taste, varying much in quality. Some Malwa opium lately analysed yielded only 2 per cent. of morphia, was oily and mucilaginous, and appeared to have been obtained by expression of the capsules. Dr Smyttan, late Opium Inspector at Bombay, obtained from 3 to 5 per cent. of morphia from some varieties, and from 7¼ to 8 per cent. from finer kinds. Some *Kandeish opium* yielded to Mr E. Solly 72 per cent. of soluble matter, and about 7 per cent. of morphia. The East India Government opium, which is that known under the name of Bengal opium, and which is chiefly produced in the provinces of Behar and Benares, and partly in that of Cawnpore, is also of different qualities; that intended for medicinal use in the hospitals in India is of very fine quality, of a brown colour, and fine odour, packed with great care in 4 lb. and 2 lb. squares covered with layers of mica, and further defended by a case of brown wax half an inch in thickness. This *Patna garden opium*, cultivated, prepared, and selected exclusively for the dispensaries, has yielded about 7 to 8 per cent. and sometimes more (10½) of morphia. It is of this kind that Christison says, "I have examined specimens little inferior to average Turkey opium in the quantity of morphia they contained."

Dr Butter describes the quantity of opium from each capsule as varying according to soil, irrigation, and to the quantity of dew which falls, but averaging about 1 grain from each quadruple incision. The tears are of a reddish colour externally, but semi-fluid in the interior, and of a reddish-white colour. The juice is apt to be mixed with dew, and fraudulently with a little water, and will separate into a fluid portion (*passewah*), and into one which is more consistent, the former containing much the largest portion of the bimeconate of morphia. The whole of the day's collection is rubbed together in a mortar, so as to break down the grains, and reduce the whole to a homogeneous semi-fluid mass, which should be dried as quickly as possible in the shade, when it is called *pucka*, or matured, being called *kucha*, or raw, in its former state. All samples of opium brought for sale are submitted to a steam drying process, by which the quantity of fluid in each is easily ascertained. The opium for the China investment contains about 30 per cent. of moisture; that for medical use in India is made quite dry.

An elaborate and official account of the preparation of Indian opium has been given by Mr Eatwell, of the Opium Agency of

Behar, and is reprinted in the *Pharm. Journ.* for 1851, with woodcuts illustrating both the culture and manufacture. He has found Benares opium to contain on the average 3·21 per cent. of morphia, and 4·06 of narcotine. The soft opium, before inspissation, is drained of its more fluid part, or *passewah* (*Phar. Journ.* xi. 361). By this separation it is probable that a considerable quantity of the morphia is lost.

That exported to China, and which is highly esteemed by the Chinese, is made into cakes or balls, each containing about 4 lbs. and covered with a thick layer of poppy petals, made to adhere to the opium and to each other by means of a mixture of passewah and of inferior kinds of opium and water. It is of a dark-brown colour, of the consistence of an extract when first cut into, containing 70 per cent. of solid matter, and about 2½ per cent. of morphia.

5. **Chinese Opium.**—Most of the opium extracted in India is consumed in China. The drug is, however, produced in large quantities in the provinces of Yunnan, Kweichan, Szchuen, and Shensi, and even as far north as Ninguta. It is regarded by the natives as inferior to Indian.

6. **European Opium.**—This variety is occasionally met with. Opium might easily be produced in England if the summer were more regular. In the south of Europe the summer is probably too hot and dry. In India it can only be cultivated in the cold weather. Some good English opium has been produced, but it is irregular in strength. The quantity of morphia said to have been obtained from some specimens of French and German opium is enormous,—being from 16 to 22 per cent.

Action.—This is fully treated of under morphia (see p. 754), and the other constituents (see p. 760 *et seq.*). To sum up what is there said, two effects only are observable in the action of opium, and these are traceable in various degrees of development in each of its constituents. Taken as a whole, these bodies form a natural series connected in the following order :—Morphia, Papaverine, Narceia, Meconine, Cryptopia, Apomorphia, Codeia, and Thebaia,—the first representing the hypnotic action in the highest degree, and the last the convellent or excitant action in the highest degree,—the preponderating effect of each of the intermediate ones being indicated by its proximity to morphia or thebaia.

In poisonous doses death is the result of asphyxia from depression and final arrest of the respiratory function with great engorgement of the venous system, and the right side of the heart.

Resuscitation.—In cases of poisoning, evacuate the stomach by the use of the stomach-pump, or an emetic of mustard and salt water with tickling of the fauces. Rouse the patient by loud talking, shaking, and perambulation; administer hot coffee, tea, and salvolatile in hot water, and apply sinapisms to the nape, and ammonia to the nostrils. When the patient cannot be aroused from the stupor, artificial respiration, the use of galvanism, depletion from a jugular vein, and generally the treatment required for chloroform asphyxia (p. 341), must be employed.

Belladonna has been strongly advocated and practised as a direct antidote. I have shown, conclusively to those who will take the trouble to sift the evidence, that opium and belladonna only accelerate and intensify each other's effects; but there are medical men who do not accept the evidence which I have adduced, and one of the latest writers on the subject says,—"Certainly, in the present state of things no one would be warranted in omitting the use of belladonna (atropiæ sulph. gr. 1–20 or more subcutaneously injected) in any severe case of opium poisoning" (*Mat. Med. and Therap.* by C. D. F. Phillips, M.D., p. 66).—*From one to twenty grains of sulphate of atropia injected subcutaneously!* I think it may be safely inferred that this author, at least, has never witnessed the effects of the $\frac{1}{20}$ of a grain of sulphate of atropia used subcutaneously, and has never read that 3 grains taken by the mouth (a quantity equivalent to only $\frac{3}{4}$ of a grain subcutaneously injected) have killed a healthy woman. (See case by Dr Gross, *Amer. Jour. Med. Sci.* 1869).

Medicinal Use.—See Morphia, and the other constituents, p. 754 *et seq.*

Dose.—$\frac{1}{2}$ to 6 grains.

Pharmaceutical Uses.—In the preparation of many articles of the Pharmacopœia. The following is a list, and the quantity of opium contained in them:—

Confectio opii, 1 grain of powdered opium in 40; Emplastrum opii, 22 grains of powdered opium in half an ounce; Enema opii, the whole contains $\frac{1}{2}$ fluid drachm of tincture; Extractum opii, obtained from about twice as much opium; Extractum opii liquidum, nearly 22 grains of the extract in 1 fluid ounce; Linimentum opii, 1 volume of the tincture in 2 volumes; Pilula ipecacuanhæ cum scilla, 1 grain in $16\frac{1}{2}$ nearly; Pilula plumbi cum opio, 1 grain in 8; Pilula saponis composita, 1 grain of powdered opium in 5 grains; Pulvis cretæ aromaticus cum opio, 1 grain in 40; Pulvis ipecacuanhæ compositus, 1 grain in 10; Pulvis kino compositus, 1 grain in 20; Pulvis opii compositus, 1 grain of powdered opium in 10; Tinctura camphoræ composita, 2 grains in 1 fluid ounce; Tinctura opii, the soluble portion of 33 grains of powdered opium in 1 fluid ounce; Tinctura opii ammoniata, 5 grains in 1 fluid ounce; Trochisci opii, $\frac{1}{10}$ grain in each; Unguentum gallæ cum opio, 32 grains in 1 ounce; Vinum opii, nearly 22 grains of extract in 1 fluid ounce.

1. **Confectio Opii,** *P.B.* *Confection of Opium.*

40 grains contain 1 grain of powdered opium.

Preparation.—Mix together 192 grains of *compound powder of opium* and 1 fluid ounce of *syrup.* A substitute for the old *theriaca*, an useless and little-used preparation.

Dose.—5 grains ($=\frac{1}{10}$ of a grain of powdered opium) to 20 grains ($=\frac{1}{2}$ grain).

2. **Emplastrum Opii,** *P.B.* *Opium Plaster.*

10 parts contain 1 of powdered opium.

Preparation.—Melt 9 ounces of *resin plaster* by means of a water bath, then add gradually 1 ounce of *opium in fine powder*, and mix thoroughly.

Use.—A warming anodyne plaster in chronic rheumatism.

3. **Enema Opii,** *P.B.* *Enema of Opium.*

Preparation.—Mix together ½ fluid drachm of *tincture of opium* and 2 fluid ounces of *mucilage of starch.*

The whole may be given in persistent diarrhœa, dysentery, and in painful affections of any of the pelvic viscera.

4. **Extractum Opii,** *P.B.* *Extract of Opium.*

This is opium, *minus* the chief part of the narcotine, papaverine, and thebaia, and about 50 per cent. of insoluble matter.

Preparation.—Macerate 1 pound of *opium* in thin slices in 2 pints of *water* for twenty-four hours, and express the liquor. Reduce the residue to an uniform pulp, macerate it again in 2 pints more of *water* for twenty-four hours, and express. Repeat the operation a third time. Mix the liquors, strain through flannel, and evaporate by a water bath until the extract has acquired a suitable consistence for forming pills.

Good opium yields from 50 to 60 per cent. of extract. It should, therefore, be twice as strong as opium, if water is capable of exhausting it of its active constituent, but this does not appear to be the case.

Dose.—½ to 2 grains.

Pharmaceutical Uses.—In the preparation of Extractum opii liquidum, Trochisci opii, and Vinum opii.

5. **Extractum Opii liquidum,** *P.B.* *Liquid Extract of Opium.*

Contains nearly 22 grains of extract in 1 fluid ounce.

Preparation.—Macerate 1 ounce of *extract of opium* in 16 fluid ounces of warm *water* for an hour, stirring frequently, then add 4 fluid ounces of *rectified spirit*, and filter. The product should measure 1 pint.

This preparation is evidently an imitation of "*Battley's Sedative Solution of Opium*," and is intended for the use of those who prescribe it; but as it lacks the essence of such preparations, viz., the name, it is rarely used, and must be regarded as an encumbrance and therefore a complication to the Pharmacopœia.

Dose.—10 minims (=½ grain of extract) to 40 minims (=2 grains of extract).

6. **Linimentum Opii,** *P.B.* *Liniment of Opium.*

A mixture of equal measure of *tincture of opium* and *liniment of soap.*

Use.—A gently stimulant anodyne application.

7. **Pilula Saponis composita,** *P.B.* *Compound Pill of Soap.*

5 grains contain 1 grain of powdered opium.

Preparation.—Mix ½ ounce of *powdered opium* with 2 ounces of *hard soap* in powder, and beat into a mass, sufficiently softened by the incorporation of a little *water* to form pills. The soap is useful both to separate the particles of opium, and to facilitate its solution. It is remarkable that, while the Pharmacopœia has been so exact in its prescriptions for Decoctum papaveris, it should have been so lax in respect of this generally-used preparation as to have left the proportion of opium so indefinite.

Dose.—3 to 5 grains as an anodyne and soporific. It is often useful as a suppository.

8. **Pilula Ipecacuanhæ cum Scilla,** *P.B.* *Ipecacuanha and Squill Pill.*

23½ grains nearly contain 1 grain of powdered opium.

Preparation.—Mix together 3 ounces of *compound powder of ipecacuanha* and 1 ounce each of *squill* and *ammoniacum* in powder, and beat into a mass with a sufficiency of *treacle.*

Action and Use.—A sedative expectorant in cough.

Dose.—5 to 10 grains.

9 **Pilula Plumbi cum Opio,** *P.B.* *Lead and Opium Pill.*

8 grains contain 1 grain of powdered opium.

Preparation.—Beat 36 grains of *acetate of lead*, 6 grains of *powdered opium*, and 6 grains of *confection of roses* into an uniform mass.

Action and Use.—An anodyne astringent in intestinal fluxes or in pulmonary or other hæmorrhage.

Dose.—3 to 5 grains.

10. **Pulvis Cretæ Aromaticus cum Opio,** *P.B.* *Aromatic Powder of Chalk and Opium.*

40 grains contain 1 grain of powdered opium.

Preparation.—Mix thoroughly 9¾ ounces of *aromatic powder of chalk* and ¼ ounce of *opium* in powder, pass through a fine sieve; finally rub it lightly in a mortar. Keep it in a stoppered bottle.

Action and Use.—An astringent and anodyne in diarrhœa.

Dose.—10 grains (=¼ grain of opium) to 40 grains (=1 grain).

11. **Pulvis Ipecacuanhæ compositus,** *P.B.* *Compound Ipecacuanha Powder.*

10 grains contain 1 grain of powdered opium.

Preparation.—Mix thoroughly ½ ounce each of *ipecacuanha* and *opium*, both in powder, with 4 ounces of *sulphate of potash* in powder. Pass it through a fine sieve, and finally rub it lightly in a mortar. Keep it in a stoppered bottle.

Action and Use.—This powder, called after its author, Dr Dover. "Dover's Powder," is an excellent illustration of the advantages derived from the judicious admixture of drugs. The activity of both the opium and ipecacuanha is increased by the mechanical separation of their particles by the sulphate of potash, and the combination results in the development of a sudorific action which neither opium nor ipecacuanha possess alone in doses of 1 grain, the quantity contained in 10 grains of the powder. This powder is one of the most certain of our sudorifics and hypnotics, and as such is most appropriate in febrile irritation and insomnia. It is especially useful in diarrhœa and dysentery.

Dose.—5 to 15 grains.

12. **Pulvis Kino compositus,** *P.B. Compound Kino Powder.*

20 grains contain 1 grain of powdered opium.

Preparation.—Mix thoroughly $3\frac{3}{4}$ ounces of *kino* in powder, $\frac{1}{4}$ ounce of *powdered opium,* and 1 ounce of *cinnamon bark* in powder. Pass it through a fine sieve, and finally rub it lightly in a mortar. Keep it in a stoppered bottle.

Action and Use.—An anodyne astringent in diarrhœa and hæmorrhage from the alimentary canal.

Dose.—5 grains ($= \frac{1}{4}$ grain of opium) to 20 grains ($=1$ grain).

13. **Pulvis Opii compositus,** *P.B. Compound Powder of Opium.*

10 grains contain 1 grain of powdered opium.

Preparation.—Mix thoroughly together $1\frac{1}{2}$ ounce of *opium* in powder, 2 ounces of *black pepper,* 5 ounces of *ginger,* 6 ounces of *caraway fruit,* and $\frac{1}{2}$ an ounce of *tragacanth,* all in powder, pass the mixture through a fine sieve, and finally rub it lightly in a mortar. Keep it in a stoppered bottle.

This powder represents Confectio opii in the dry state. It is carminative and anodyne, and may be used in flatulent colic, and with chalk mixture in atonic diarrhœa.

Dose.—2 grains ($= \frac{1}{5}$ grain powdered opium) to 5 grains ($=\frac{1}{2}$ grain).

14. **Tinctura Camphoræ composita,** *P.B. Compound Tincture of Camphor. Paregoric.*

4 fluid drachms contain the soluble part of 1 grain of powdered opium.

Preparation.—Macerate 40 grains each of *opium* in coarse powder and *benzoic acid,* 30 grains of *camphor,* and $\frac{1}{2}$ fluid drachm of *oil of anise,* with 1 pint of *proof spirit,* for seven days in a closed vessel, with occasional agitation; then filter, and add sufficient *proof spirit* to make 1 pint. This is a sherry-coloured fluid, smelling of camphor and anise, and becoming milky when mixed with water. Opium is the principal constituent.

Action and Use.—A carminative sedative, employed as an anodyne and sedative, chiefly in cough.

Dose.—$\frac{1}{2}$ fluid drachm ($=\frac{1}{8}$ grain of opium) to 2 fluid drachms ($=\frac{1}{2}$ grain).

15. **Tinctura Opii,** *P.B. Tincture of Opium* or *Laudanum.*

Contains the soluble portion of nearly 33 grains of powdered opium in 1 fluid ounce.

Preparation.—Macerate $1\frac{1}{2}$ ounce of *opium* in coarse powder in 1 pint of *proof spirit* for seven days, then strain, press, filter, and add sufficient *proof spirit* to make 1 pint.

Laudanum is, of all the preparations of opium, its best representative. It contains more of the peculiar resin than the aqueous extract, and this substance appears to stand in intimate relation to the more active constituents. It also contains the odoriferous principle, and more narcotia. It is of a deep reddish-brown colour, possesses the full heavy odour of opium, and its bitter taste. The sp. gr. is about 0·940. 13¼ minims represent 1 grain of dry opium.

Use.—As a narcotic, it has the advantage over solid opium in being more readily absorbed.

Dose.—5 to 40 minims. For an infant, from 1 to 2 small drops.

16. **Tinctura Opii ammoniata,** *P.B.* *Ammoniated Tincture of Opium. Scotch Paregoric.*

Contains the soluble part of 5 grains of powdered opium in 1 fluid ounce.

Preparation.—Macerate 100 grains of *opium* in coarse powder, 180 grains each of *saffron* (cut small) and *benzoic acid*, 1 fluid drachm of *oil of anise*, in a mixture of 4 fluid ounces of *strong solution of ammonia*, and 16 fluid ounces of *rectified spirit*, for seven days in a well-closed vessel, with occasional agitation; then strain, press, filter, and add sufficient *rectified spirit* to make 1 pint.

Morphia is but feebly soluble in ammonia; but 125 grains of opium = 100 of the dry powder, contain not more than 10 grains of morphia, and this quantity is completely dissolved in the ammoniacal tincture. Some of the other constituents are more or less completely dissolved in this tincture than in Tinctura opii.

Use.—Combines the properties of ammonia and opium, and as such is a stimulant antispasmodic and anodyne in cough, especially pertussis.

Dose.—½ to 1 fluid drachm. 96 minims represent 1 grain of powdered opium.

17. **Trochisci Opii,** *P.B.* *Opium Lozenges.*

Each contains $\frac{1}{10}$th of a grain of extract of opium.

Preparation.—Add 72 grains of *extract of opium*, softened by means of a little water, and ½ fluid ounce of tincture of *tolu* to 6 ounces of *extract of liquorice* heated in a water bath. When the mixture is reduced to a proper consistence, remove it to a slab, add 16 ounces of *refined sugar* in powder, and 2 ounces of *gum acacia* in powder, previously rubbed together, and mix thoroughly. Divide the mass into 720 lozenges, and dry these in a hot-air chamber with a moderate heat.

Use.—To allay irritable cough.

Dose.—1 to 6 lozenges.

18. **Unguentum Gallæ cum Opio,** *P.B.* *Ointment of Galls and Opium.*

60 grains contain 4 grains of powdered opium.

A mixture of 32 grains of powdered *opium* with 1 ounce of *ointment of galls.*

Action and Use.—An astringent opiate application for hæmorrhoids or fluxes from the rectum.

19. **Vinum Opii,** *P.B.* *Wine of Opium.* *Sydenham's Laudanum.*

Contains nearly 22 grains of extract of opium in 1 fluid ounce, corresponding in strength with the Extractum opii liquidum.

Preparation.—Macerate 1 ounce of *extract of opium* and 75 grains each of bruised *cinnamon* and bruised *cloves* in 1 pint of *sherry* for seven days in a closed vessel, with occasional agitation.

Use.—This preparation is historically interesting, but its use is not at all obvious. It is destitute of the aroma, but may be said to have a more agreeable taste than the tincture; patients, however, do not object to the taste or flavour of the latter. If it be thought more suitable for ophthalmic use than the tincture, it is less so than the fluid extract, which contains the same quantity of spirit, but none of the irritant oil of cinnamon and cloves. Because opium sometimes causes sickness, the physicians who compiled the older Pharmacopœias thought a combination with aromatics would obviate this tendency; but this is due not to a local action on the stomach, but to the disturbance of the nerve centres (see p. 754).

Dose.—10 minims (= ½ grain of extract) to 40 minims (= 2 grains).

MORPHIA, $C_{17}H_{19}NO_3,H_2O = 285 + 18$. *Morphine.* F. *Morphine.* G. *Morphin.*

This, the chief and essential constituent of opium, forms from 6 to 12 per cent. of the drug. It may be prepared by the process given (p. 743) for ascertaining the proportion in a given quantity of opium; or as follows:—

Preparation.—1. Macerate 1 pound of sliced *opium* for twenty-four hours with 2 pints of *water*, and decant. Repeat this process with the residue a second and third time, and finally subject the residue to strong pressure. Evaporate the united liquors in a water bath to a pint, and strain through calico. 2. Add ¾ of an ounce of *chloride of calcium* dissolved in 4 fluid ounces of *water*, and evaporate until the solution solidifies on cooling. Wrap the mass in a double fold of strong calico, and subject it to powerful pressure, preserving the dark fluid (mother-liquor A; see Codeia) which exudes. 3. Triturate the squeezed cake with about half a pint of boiling distilled water, filter, and wash the residue (insoluble meconate of lime) well with boiling distilled water (in order to remove all traces of hydrochlorate of morphia). 4. Evaporate the filtrate until it solidifies on cooling, subject it to pressure as before, and if the mass be still much coloured, dissolve it in water, again evaporate to solidification, and subject it to pressure as before, always preserving the expressed liquid (more mother-liquor A). 5. Dissolve the pressed cake in 6 fluid ounces of *boiling water;* add ¼ of an ounce of purified *animal charcoal*, and digest for twenty minutes; filter, and having washed both filter and charcoal with boiling water (in order to avoid waste), add to the solution thus obtained *solution of ammonia* in slight excess. Let the pure crystalline morphia, which separates as the liquid cools, be collected on a filter and washed with cold water until the washings cease to give a precipitate with solution of nitrate of silver acidulated by nitric acid (indicating that the ammonium chloride has been completely washed away).

A little more morphia may be obtained from the mother-liquors. (See Codeia.)

In the first stage of the above process the opium is exhausted of its morphia and codeia, which are contained in the aqueous solution in combination with meconic acid. Resin, oil, acid extractive, and small quantities of some of the other constituents, are also contained in the infusion. In the second the meconic acid is precipitated in combination with the lime, the hydrochloric acid being transferred to the morphia and codeia, forming hydrochlorates which are held in solution. The insoluble meconate of lime, a little sulphate of lime, and the mother-liquors holding the other constituents of opium in solution, are separated in the third stage. Solid cakes of crystalline hydrochlorate of morphia and codeia, freed from resin and extractive matter, are obtained in the fourth stage; and by the fifth the morphia is precipitated, the codeia remaining in solution with the ammonium chloride.

Characters and Tests.—Morphia crystallises in short six-sided prisms; but these are usually so minute, that it has the appearance of a pure white powder. It is odourless, but very bitter. It fuses into a yellow, oily-looking fluid at 340°, and loses an atom of water; on cooling, it concretes into a colourless, crystalline mass. At about the temperature of 350° the alkaloid sublimes, and may be condensed on a hot plate in unaltered prisms (Dr Guy). At a higher temperature it is charred, with the evolution of ammonia. It is soluble in 1000 times its weight of cold, and in 400 of boiling water; the solution has an alkaline reaction on turmeric paper. It requires 40 parts of cold anhydrous alcohol and 30 parts of rectified spirit at 212° for solution; and is insoluble in æther and chloroform, but soluble in oils, both fixed and volatile. The fixed alkalies and alkaline earths also dissolve it, and deposit it unchanged, as they absorb carbonic acid from the air. It is very sparingly soluble in ammonia. It is freely soluble in dilute acids, forming bitter salts.

The **Salts of Morphia** crystallise readily; they are very soluble in water and in alcohol, but are insoluble in æther. Tartaric acid added to a solution of a salt of morphia prevents its precipitation by bicarbonate of soda. Salts of morphia are precipitated by tannic acid, but not by gallic acid or gallates. Concentrated nitric acid converts morphia or its salts into oxalic acid with the production of an orange-yellow colour. A mixture of nitric and sulphuric acids forms a green solution; a neutral solution of perchloride of iron turns morphia blue; but the colour is destroyed by excess of acid.

Action.—The following conclusions are taken from my work, *The Old Vegetable Neurotics:* On the *brain.*—The *general* phenomena are the same in all animals and every variety of constitution, and they are plainly the result of two opposite effects—a hypnotic, which includes anæsthesia, and an excitant, which includes cramp and convulsions. The *specific* and *individual* effects are determined by peculiarities of nervous constitution. In some these two effects on the nervous system are so equally balanced, that in moderate doses the drug has only tonic and stimulant effects, which in increased doses may rise to delirium. In others hypnosis prevails, and the stimulant effect is apparently confined to the heart. In a third class the excitant action counteracts the hypnotic, and insomnia with restlessness or delirium results. Women are more liable to its excitant action than men; and amongst women, individuals of a highly emotional, excitable, and energetic temperament are those to whom opium in any form is a very distressing remedy, and when used hypodermically, a dangerous one. On the *spinal cord.*—In man this is chiefly confined to the medulla after moderate doses, and the effects are not uniform in different persons. In the nervous class above referred to, derangement of the pneumogastric nerves is liable to follow. Its sentient branches are blunted, and the lungs no longer invite a flow of blood; its motor branches convey only cramp to the muscular parts; the mechanical suction power of the chest is depressed, and the lungs themselves tend to collapse. The right heart soon becomes distended, cardiac distress is complained of, the pulse loses force and volume, intermits, and syncope results. The attendant symptoms, retching and vomiting, are consequences of similar disturbance of the gastric branches. Under the influence of morphia *the whole respiratory function is depressed*, and the breathing becomes more or less irregular, and interrupted by sighs. During the action of a medicinal dose, the respiratory movements decrease $\frac{1}{4}$ to $\frac{1}{3}$, and after a poisonous dose they are progressively reduced in number and extent until they become imperceptible, and ultimately cease altogether. *On the sympathetic*, the action is stimulant, and so long as the respiratory function is not notably depressed, the pulse is increased in rapidity, volume, and force. *On nutrition.*—During the action of opium, digestion and absorption are retarded; and if a large dose be taken by the mouth, its absorption, after a time, is completely suspended. So long as any hypnotic and anæsthesiant effects remain, the excretions are retained; but when the effects are simply hypnotic and stimulant, and the patient is accustomed to its use, the secretions are abundant and free. *On the pupil.*—In man, contraction of the pupil is the most constant of all the effects of opium, and comes on in ten or fifteen minutes after the subcutaneous use of the drug. It occurs independently of hypnosis.

The effects of a moderate dose of morphia (1 grain by the mouth, or $\frac{1}{4}$ grain hypodermically), in those who are readily influenced by the hypnotic action of opium, are somnolency with giddiness, and a sense of fulness in the head, soon followed by sound sleep lasting for several hours. In those not influenced readily by the hypnotic action, there follow restlessness, wakefulness, and often nausea. As often as sleep comes on it is soon disturbed by vivid dreams, and the intervals of vigilance by equally vivid illusions and delusions,—waking dreams, usually of a fearful character. After the lapse of several hours the patient will sometimes fall into a refreshing slumber. Unless the patient be accustomed to the drug there will usually be in both cases, but much more so in the latter, nausea, headache, and muscular debility on waking, and for a few hours subsequently.

The greatest caution must be used in giving opium or morphia hypodermically, and on no account should the dose of the latter exceed the $\frac{1}{6}$th of a grain for a man and the $\frac{1}{12}$th of a grain for a woman, as an initial dose, when we are ignorant of the effects of the drug on the individual. Even the $\frac{1}{12}$th of a grain will sometimes cause extreme nausea, faintness, with intermittent pulse, for two or three hours; and after larger doses the patient has suddenly fallen back, pallid and gasping for breath, the pulse and respiration imperceptible, and has continued in this state of dangerous syncope for two or three minutes, and then, under the influence of stimulants, has revived to a condition of great and prolonged distress. I have shown (*op. cit.* p. 302) that these effects, which are due to derangement of the vagus, may be prevented by the simultaneous, or better, the previous injection of the $\frac{1}{60}$th of a grain of sulphate of atropia. They may also be ameliorated, and the nausea and faintness ultimately removed by its subsequent use.

In proportion as the dose of morphia is increased, so are the effects above described intensified and prolonged; and after a poisonous dose the somnolency passes into stupor, and the stupor into coma, the muscular system is completely relaxed, the whole surface becomes cold, bloodless, and clammy, the pupils completely contracted, the pulse feeble and thready, the breathing slow and shallow with stertor, or, near the end, imperceptible to the ear and eye.

Medicinal Uses.—Of all neurotics—indeed of all medicines—opium is by far the most beneficial, for by it we are enabled to give sleep, and to soothe the morbid sensibility of an over-excited or exhausted nervous system.

The *contra-indications* for its use are few and simple. 1. It must not be given alone to persons in whom it produces restlessness, nausea, and faintness; but when judiciously combined with atropia, conium, chloral hydrate and its allies, hypnotic effects may be obtained even in these individuals. 2. In pulmonary and in renal congestion, and in the moist stage of diffuse bronchitis, its use must be avoided, or it must be given in small doses and with extreme caution. 3. In apoplexy it is regarded as an unsafe remedy, but the cases are few that are not benefited by its use. Opium in this condition is of course superfluous and noxious, if there be already deep stupor with slow breathing; but when the cerebral excitement prevents sleep, it should be given without hesitation in moderate doses, and not repeated under six or eight hours.

In all other conditions it may be freely employed as a *hypnotic*, *antispasmodic*, and *anodyne*. So grateful is its influence in painful disorders that there is danger of its abuse. While we should never withhold it in malignant disease, but, on the contrary, proportion the dose to the severity of the pain, we ought never to employ it in simple neuralgia, but rather seek to remove the cause of the disorder. Both mind and body have been wrecked, in many a case, by the pernicious use of frequent hypodermic injections of morphia for simple neuralgia. Even in the severest forms of rheumatic neuritis or facial neuralgia, the injection should never be given oftener than once a week, but then in effectual doses.

As an *anodyne and sedative* in painful inflammatory affections, such as acute pleurisy and pneumonia, peritonitis, orchitis, opium is most valuable, not only in relieving pain, but, I am convinced, in diminishing the irritability of the vaso-motor nerves implicated in the inflammatory process. In gastritis and entritis its beneficial action is equally well marked, and it probably controls diarrhœa, by directly relieving the irritability of the congested blood-vessels. In the restlessness, insomnia, and delirium which attend the specific fevers, and which may supervene on any pyrexial condition, opium is the appropriate remedy. Its use is not only necessary but most beneficial in the delirium of typhus, and the more active cerebral excitement which occasionally arises in enteric and scarlet fevers, whence its beneficial influence in phrenitis from any cause may be safely inferred. It is the appropriate remedy in traumatic delirium and *delirium a potu.* In the latter condition the dose must be proportionate to the need. Where repeated doses of 30 or 40 minims of tincture of opium only serve to excite, a single dose of two or even three drachms will rarely fail to induce sleep, from which the patient will awake refreshed and ready to sleep again. In cardiac diseases, whether of the muscular structure or of the valves, opium may be given, provided that there is no undue excitement of action. In these conditions, and in diseases of the blood-vessels other than aneurism, such as atheroma and varix, the influence of moderate doses is undoubtedly tonic. In diabetes, opium is the most valuable remedy that we possess; its action in this disease, even when given to the extent of a grain of solid opium every two hours, is tonic and sedative, the degree of somnolency in many cases being very slight; moreover, in some cases it greatly diminishes the quantity of water and sugar eliminated.

Opium, alone or in combination with conium, is the most potent instrument for the repression of maniacal excitement.

As an antispasmodic, as in the passage of gall stones, renal calculi, scybala, it should always be given in combination with equally large doses of belladonna, in order to counteract its occasional tendency to induce contraction in the circular fibres of the viscera.

For internal use opium is generally preferable to morphia; the latter is more suitable for hypodermic injection.

Dose.—Morphia may be given, dissolved in sufficient dilute acid, by the mouth, in doses from $\frac{1}{4}$ to 2 grains; by the hypodermic method, from $\frac{1}{12}$ to $\frac{1}{2}$ a grain, with the precautions above stated. If slow absorption for the relief of topical pain be desired, 1 grain finely levigated may be dusted on the surface, denuded of its epidermis by a blister.

MORPHIÆ ACETAS, *P.B.* Acetate of Morphia,
$C_{34}H_{19}NO_6,C_4H_3O_3+HO$ or $C_{17}H_{19}NO_3,C_2H_4O_2=245$.

Preparation.—Dissolve 2 ounces of *hydrochlorate of morphia* in 1 pint of *water*, and add *solution of ammonia* until the morphia is wholly precipitated and the liquid is slightly alkaline. Collect the precipitate on a filter, wash it with water, then having transferred it to a porcelain dish, add 4 ounces of water and a sufficiency of *acetic acid* to neutralise and dissolve it. Evaporate the solution on a water bath until it concretes on cooling. Lastly, dry the salt with a gentle heat, and reduce it to powder.

Characters and Tests.—A white powder imperfectly crystalline, soluble in water and in spirit. From its solution potash throws down a precipitate which is dissolved by excess of the alkali. It exhibits the characters of a salt of morphia (see p. 754), and when heated with sulphuric acid evolves acetic acid.

Acetate of morphia is slightly deliquescent, and its solution loses acid on evaporation: this makes the salt imperfectly soluble and of uncertain composition.

Dose.—$\frac{1}{8}$ to 1 grain by the mouth; $\frac{1}{12}$ to $\frac{1}{2}$ grain subcutaneously, with the precautions above given under morphia.

1. **Liquor Morphiæ acetatis,** *P.B. Solution of Acetate of Morphia.*

2 fluid drachms = 1 grain of the acetate.

Preparation.—Mix 8 minims of *dilute acetic acid* and 2 fluid drachms of *rectified spirit* with 6 fluid drachms of *water*, add 4 grains of *acetate of morphia*, and dissolve.

Dose.—10 minims ($=\frac{1}{12}$ of a grain) to 120 minims ($=1$ grain).

2. **Injectio Morphiæ hypodermica,** *P.B. Solution of Acetate of Morphia for hypodermic injection.*

12 minims = 1 grain of the acetate.

Preparation.—Dissolve 88 grains of *hydrochlorate of morphia* in 2 ounces of *water*, aiding the solution by a gentle heat; then add *solution of ammonia*, so as to precipitate the morphia and render the liquid slightly alkaline; allow it to cool; collect the precipitate on a filter, wash it with water and allow it to drain, then transfer the morphia to a small porcelain dish containing about an ounce of water; apply a gentle heat, and carefully add *acetic acid* until the morphia is dissolved and a very slightly acid solution is formed; add now sufficient water to make the solution measure exactly 2 fluid ounces; filter, and preserve in a stoppered bottle excluded from the light.

The 88 grains of hydrochlorate contain 66·79 grains of morphia, which (allowing 0·05 of a grain for waste) forms with acetic acid 80 grains of acetate.

A solution of definite strength cannot always be obtained by the use of the dry acetate, but this object is secured by the above process.

Characters and Tests.—A clear solution, free from any solid particles. Very slightly acid to test paper. A fluid drachm, rendered slightly alkaline by the addition of solution of ammonia, yields a precipitate of morphia, which, after being washed and dried, should weigh 4·3 grains, corresponding to 5 grains of acetate of morphia.

Dose by Subcutaneous Injection.—1 minim = ($\frac{1}{12}$th of a grain of salt) to 6 minims (= $\frac{1}{2}$ a grain).

MORPHIÆ HYDROCHLORAS, *P.B.* **Hydrochlorate of Morphia.**

$C_{34}H_{19}NO_6HCl + 6HO$ or $C_{17}H_{19}NO_3HCl,3H_2O = 321{\cdot}5 + 54$.

Preparation.—Take $1\frac{1}{4}$ ounce of *morphia* prepared as above described (p. 753), diffuse it through 2 fluid ounces of *boiling water* placed in a porcelain capsule kept hot, and add, constantly stirring, *dilute hydrochloric acid*, proceeding with caution, so that the morphia may be entirely dissolved and a neutral solution obtained. Set aside to cool and crystallise. Drain the crystals, and dry them on filtering paper. By further evaporation of the mother-liquor and again cooling, additional crystals may be obtained.

Characters and Tests.—In white flexible acicular prisms of a silky lustre, not changed by exposure to the air, soluble in spirit, in 16 parts of cold, and its own weight of boiling water. The aqueous solution gives a white curdy precipitate ($AgCl$) with nitrate of silver, and a white one (morphia) with potash, soluble in excess of the alkali. Moistened with strong nitric acid it becomes orange-red, and, with solution of perchloride of iron, greenish-blue. Entirely destructible by heat without residue. 20 grains of the salt dissolved in $\frac{1}{2}$ an ounce of warm water, with ammonia added in the slightest possible excess, give on cooling a crystalline precipitate, which, when washed with a little cold water and dried by exposure to the air, weighs 15·18 grains,—the proper proportion of morphia.

Dose.—$\frac{1}{8}$ to 1 grain by the mouth; from the $\frac{1}{12}$th to $\frac{1}{2}$ grain used hypodermically, with the precautions given under morphia.

1. **Liquor Morphiæ hydrochloratis.** *Solution of Hydrochlorate of Morphia.* 2 fluid drachms = 1 grain of the hydrochlorate.

Preparation.—Mix 8 minims of *dilute hydrochloric acid* and 2 fluid drachms of *rectified spirit* with 6 fluid drachms of *water*, add 4 grains of *hydrochlorate of morphia* and dissolve.

Dose.—10 minims (= $\frac{1}{12}$th of a grain of the salt) to 120 minims (= 1 grain).

1. **Suppositoria Morphiæ.** *Morphia Suppositories.*

Each contains $\frac{1}{2}$ grain of hydrochlorate of morphia.

Preparation.—Melt 20 grains of *white wax* and 90 grains of *oil of theobroma* with a gentle heat, then add 6 grains of *hydrochlorate of morphia*, previously mixed with 64 grains of *benzoated lard*, and mix all the ingredients thoroughly. Pour the mixture while it is fluid into suitable moulds of the capacity of 15 grains; or the fluid mixture may be allowed to cool, and then be divided into twelve equal parts, each of which shall be made into a conical or other convenient form for a suppository, which will contain ½ a grain of hydrochlorate of morphia.

Action. Uses.—When introduced *per anum*, the morphia, becoming dissolved, exerts its anodyne and constipating action. Used in painful affections of the lower bowel, bladder, or uterus; in difficult parturition, after operation for stone, or in dysentery.

2. **Suppositoria Morphiæ cum Sapone**, *P.B. Morphia and Soap Suppositories.*

Each contains ½ of a grain of hydrochlorate of morphia.

Preparation.—Mix 6 grains of *hydrochlorate of morphia* with 50 grains of *glycerin of starch*, and 100 grains of *curd soap*, and add sufficient starch to form a paste of suitable consistence. Divide the mass into twelve equal parts, and form them in a conical or cylindrical shape, convenient for use as a suppository.

The advantage of this suppository over the former one is that it acts more slowly.

3. **Trochisci Morphiæ**, *P.B. Morphia Lozenges.*

Each contains the $\frac{1}{36}$th of a grain of hydrochlorate of morphia.

Preparation.—Dissolve 20 grains of *hydrochlorate of morphia* in ½ fluid ounce of *water*, add this solution to ½ fluid ounce of *tincture of tolu*, previously mixed with 2 fluid ounces of *mucilage of gum acacia*; then add 1 ounce of *gum acacia* in powder, previously mixed with 24 ounces of *refined sugar* in powder, and form into a proper mass, using more mucilage if necessary. Divide into 720 lozenges, and dry these in a hot-air chamber with a moderate heat.

Dose.—1 to 12 lozenges during the day to relieve cough.

4. **Trochisci Morphiæ et Ipecacuanhæ**, *P.B. Morphia and Ipecacuanha Lozenges.*

Each contains the $\frac{1}{36}$th of a grain of hydrochlorate of morphia, and $\frac{1}{12}$th of a grain of ipecacuanha.

Preparation.—Mix 60 grains of *ipecacuanha* in fine powder with 2 fluid ounces of *mucilage of gum acacia* and ½ fluid ounce of *tincture of tolu;* add this to a solution of 20 grains of *hydrochlorate of morphia* in ½ ounce of *water*, and make into a paste, as in the preceding preparation, using the *gum* and *sugar* in the same proportions, and divide as before into 720 lozenges.

Dose.—1 to 12 lozenges during the day to relieve cough.

APOMORPHIA. $C_{17}H_{17}NO_2=263$.

This base, lately discovered by Matthiessen and Wright (*Proc. Roy. Soc.* 1869), contains the elements of morphia, minus H_2O. It may be readily obtained from morphia or its hydrochlorate by heating it to 302° with an excess of hydrochloric acid in a sealed tube for three hours. A molecule of water is separated, and the hydrochlorate of morphia converted into hydrochlorate of apomorphia: $C_{17}H_{19}NO_3, HCl = C_{17}H_{17}NO_2, HCl + H_2O$. The base may be separated by solution in water and the cautious addition of ammonia. It is amorphous; moderately soluble in water and in æther, more soluble in alcohol and in chloroform. With nitric acid, or a mixture of bichromate of potash and sulphuric acid, it gives a brucia-red, and with perchloride of iron an amethyst purple. It forms crystalline salts.

Hydrochlorate of Apomorphia, $C_{17}H_{17}NO_2, HCl = 298{\cdot}5$.

This salt is prepared as above stated. A specimen received from Messrs T. and H. Smith of Edinburgh presents the following characters:—

Characters.—A greyish, apparently amorphous powder, but under the microscope seen to be composed of a mixture of long and narrow, and short and broad six-sided prisms bevelled at the ends; gives with nitric acid, or a mixture of sulphuric acid and bichromate of potash, a rich maroon colour, and with warm perchloride of iron a bluish-black. It is feebly soluble in alcohol, readily soluble in water; on spontaneous evaporation it separates from the former in colourless prisms, and from the latter in rhombs and prisms of a delicate bluish-green or glacier tinge; the aqueous solution is nearly colourless, slightly bitter, and gives an abundant chalk-like precipitate with solutions of both ammonia and potash, soluble in excess with the formation of a satiny film on the surface; the ammoniacal solution soon assumes a bluish-green colour, and the potash one a cherry-red.

Action.—The effects of apomorphia are emesis, hypnosis, and sometimes syncope. Subcutaneously injected it causes, in the course of two or three minutes, a feeling of oppression in the epigastrium, vertigo, followed by retching, free salivation, and perspiration, ending in copious vomiting. During the next half hour the vomiting recurs at intervals of ten or fifteen minutes, and then the patient gives way to somnolency and sleeps for an hour. If these were the whole of the effects, apomorphia would be very useful, but there is usually some tendency to syncope, and occasionally the symptoms are very alarming, the pulse becoming imperceptible, the breathing apparently suspended, consciousness abolished, and twitchings of the facial muscles. This is an occasional effect of the subcutaneous use of morphia, and the same precautions indicated at p. 756, in reference to nervous peculiarities, must be used in the administration of this preparation.

Medicinal Use.—This will prove to be very limited. In poisoning where there is difficulty in the use of the stomach-pump, and in order to produce prompt emesis, it is undoubtedly a suitable remedy, but it remains for experience to decide whether it may be safely and advantageously used in inflammatory affections,—such as croup, bronchitis, &c.

Dose.—The solution for hypodermic use should be freshly prepared; 1 grain of the hydrochlorate dissolved in 2 fluid drachms of water will form a solution of convenient strength. Of this 5 minims ($=\frac{1}{24}$th of a grain)), to 12 minims ($=\frac{1}{10}$th of a grain of the salt) may be given: the $\frac{1}{17}$th of a grain has produced the alarming symptoms above referred to in a woman aged forty.

PAPAVERINE, $C_{20}H_{21}NO_4$.

Opium contains about 1 per cent. of this alkaloid.

Preparation.—A portion is separated from the mother-liquor C (see Narceia and Meconine, p. 763), but the greater part is contained in the precipitate formed in the isolation of Thebaia (see p. 765). This precipitate is powdered, boiled with alcohol, and the alcohol subsequently removed by distillation. The dark residue is treated with dilute hydrochloric acid: a solution of narcotine and hydrochlorate of papaverine is thus obtained, this is filtered from the undissolved resin, and evaporated spontaneously; the latter salt crystallises, leaving the narcotine in solution.

Characters.—Colourless shining prisms, long, slender, and six-sided; or short, flat, and four-sided, with two acute edges, resembling a two-edged blade; tasteless, soluble in cold nitric acid, forming a bright orange-coloured fluid. Soluble in cold sulphuric acid without coloration; but the solution becomes first purple and then a splendid and permanent purplish-red when strongly heated. Soluble in 1200 parts of boiling, and in 3000 of cold water. Soluble in boiling alcohol, nearly the whole separating in beautiful stellate clusters on cooling. Soluble in dilute acetic and hydrochloric acids, forming nauseously bitter solutions. The *hydrochlorate* separates from acid solutions in large and brilliant prisms, four-sided, bevelled at the ends, or in triangular prisms exactly resembling three of triple phosphate. It is soluble in 12 parts of boiling water.

Action and Dose.—A pure but very feeble hypnotic; 6 grains of the hydrochlorate in solution, given to a delicate woman by the mouth, had merely a slight anodyne effect: 2 grains used hypodermically caused somnolency, equal in degree, as far as I could judge, to that produced by $\frac{1}{6}$th of a grain of morphia.

NARCEIA or Narcein, $C_{23}H_{29}NO_9$.

Opium contains from 0·1 to 0·7 per cent. of this alkaloid.

Preparation.—The dark mother-liquor B (see preparation of Codeia) is diluted with water, treated with ammonia, and filtered. The filtrate which contains the narceia and meconine is purified from colouring matter by the addition of acetate of lead, so long as it causes a precipitate. This is separated, and the excess of lead removed by a current of sulphuretted hydrogen. On evaporating the filtered fluid to a syrup, the narceia separates on cooling as a voluminous mass of silky crystals. These are separated from the fluid (mother-liquor C), and recrystallised.

Characters.—A compressed, asbestos-like mass of soft acicular crystals, very light and colourless. Soluble in 100 parts of boiling water, and in 400 parts at 60°; still less soluble in alcohol. Insoluble in chloroform and in æther. Soluble in 66 parts of glycerin at 60°, and in 12 parts when acidulated with hydrochloric acid. Dilute hydrochloric acid colours it azure-blue, the strong acid dissolves it without coloration. Sulphuric acid dissolves it with the production of a rich amber colour, which rapidly changes to that of port wine, and when heated to a chocolate-brown and dingy purple.

Action.—A pure hypnotic, 1 grain by the areolar tissue being equivalent to $\frac{1}{8}$ of a grain of a salt of morphia. It is eliminated by the kidneys, and deposited in the crystalline form in its straight tubules (see *Old Veg. Neurotics*, p. 148), producing anuria.

Use and Dose.—Impracticable, being too costly to be given in efficient doses (5 to 10 grains) by the mouth, and too insoluble to be employed hypodermically.

MECONINE or Opianyl, $C_{10}H_{10}O_4$.

Opium contains from 0·1 to 0·2 per cent. of this constituent (Morson).

Preparation.—The mother-liquor C, from the narcein, is shaken with $\frac{1}{4}$ of its bulk of æther, and the ætherial solution separated, and this is repeated as long as the æther is coloured. The æthereal solutions are then mixed and distilled to a small bulk. Water is added to the residue. This precipitates a mixture of meconine and papaverine. The latter is dissolved out by hydrochloric acid, and the meconine is dissolved in water and crystallised.

Characters.—Fine white silky prisms in bulk resembling sulphate of quinine. It is freely soluble in hot water and in hot glycerin, from both of which nearly the whole is deposited on cooling; freely soluble in chloroform, less soluble in æther and in alcohol. Gently heated with sulphuric acid it assumes an emerald green colour, and on increasing and continuing the heat it passes through a neutral tint to a permanent purple.

Action and Dose.—Simply tranquillising and hypnotic, but as feeble as narceia, over which it has the advantage of greater solubility. It is, however, impossible to get more than 2 grains beneath the skin by two punctures, and this dose produces only slight somnolency after some hours. 5 grains by the mouth produces no effect.

CRYPTOPIA, $C_{23}H_{25}NO_5$.

Opium contains about ·003 per cent. of this alkaloid. It is probably one of the derivative constituents of opium.

Characters.—Colourless six-sided prisms, soluble in 300 parts of boiling water. Soluble in chloroform, very slightly in alcohol, and still less so in æther; readily soluble in water, slightly acidulated with hydrochloric or acetic acids. The hydrochlorate exhibits the characteristic property of gelatinising. The solutions are more bitter than those of morphia.

Cryptopia disappears slowly and silently in cold nitric and sulphuric acids, developing an orange colour with the former, and a splendid purple with the latter. On heating, the purple changes to a dark sap-green.

Action and Dose.—Excitant and hypnotic, and causing dilatation of the pupils under the latter influence. The hypnotic effect of 1½ grain used hypodermically is equivalent to ¼ of a grain of a salt of morphia administered in the same way.

CODEIA or Codein, $C_{18}H_{21}NO_3$.

Opium contains from ¼ to 1 per cent. of this alkaloid.

Preparation.—The mother-liquors A (see preparation of morphia) from which the morphia has been separated are further concentrated, and solution of potash is then added, the codeia is deposited as the liquid cools, and is separated from the dark fluid (mother-liquor B), decolorised by animal charcoal, and recrystallised.

Characters. — Fine rhombic friable crystals, colourless, bitter. Soluble in 25 parts of boiling water, and in 50 parts at 60°; in less than 2 parts of alcohol or chloroform, but requiring 40 parts of æther. Separates from water and alcohol in rhombic octohedra and prisms as perfect, brilliant, and refractive as those of triple phosphate.

The hydrochlorate forms slender four-sided prisms. Both the alkaloid and this salt remain colourless in solution of perchloride of iron. The former dissolves in nitric acid, giving a pale greenish-orange solution; and in warm sulphuric acid without discoloration, the solution when strongly heated assuming a faint brown tinge, which rapidly darkens to a neutral tint, and then blackens with decomposition.

Action.—Like morphia, codeia possesses both a hypnotic and an excitant action, but the excitant action is the stronger, producing convulsions and great derangement of the respiratory function in the lower animals.

In those who are susceptible of the hypnotic action of opium it induces somnolency when given in doses of 1 or 2 grains by the areolar tissue. The effects, however, are much more transient than those of the other somniferous constituents of opium. Given by the skin, 2 grains are equivalent as a sporific to ¼ of a grain of morphia. But this large dose also causes giddiness, nausea, increased temperature of the skin, acceleration of the pulse, with increase of volume and arterial pressure, and contraction of the pupil; and 4 grains by the mouth will cause the same effects in any but a very strong man.

As a medicine it possesses no advantage over morphia, but the reverse.

Use and Dose.—Codeia is prescribed in the French Codex in the form of syrup, in doses varying from the 0·15 to the 0·6 of a grain, and is used as a sedative in cough. Dr Pavy has lately advocated its use in diabetes, but it has less influence in this disease than opium. From ½ to 2 grains may be given for a dose.

THEBAIA or Paramorphia, $C_{19}H_{21}NO_3$.

Opium contains about ½ per cent. of this alkaloid; it was at first regarded as peculiar to Egyptian opium.

Preparation.—By distillation of the alcoholic mother-liquor E, from which narcotine has crystallised (see preparation of Narcotine). The dark brown residue is treated with acetic acid, and the solution separated from insoluble matter, and an excess of basic acetate of lead added, the papaverine, narcotine, and resin are precipitated, the thebaia remaining in solution. Excess of lead is removed by sulphuric acid, and the thebaia is precipitated from the filtrate by the addition of ammonia.

Characters.—Colourless rectangular plates or prisms, soluble in about 45 parts of alcohol, more soluble in æther, and still more soluble in chloroform, and separating from these solvents in silvery crystals of the original form. Forms with cold sulphuric acid a blood-red solution. The colour is discharged by heat, and the mixture then begins to blacken.

Action and Dose.—Excitant and feebly hypnotic. Its excitant action is identical with that of strychnia. 2 grains are equivalent to about $\frac{1}{30}$ grain of strychnia, and when given by the skin kill a small dog by intermittent tetanic spasm. I have given it by the areolar tissue, in doses varying from ¼ to 1½ grain, to an adult male who was always influenced by the hypnotic action of opium, and it invariably produced hypnosis and contraction of the pupil in him. (See *St Thomas's Hosp. Rep.* new ser. vol. ii.)

NARCOTIA or Narcotine, $C_{22}H_{23}NO_7 = 413$.

Opium contains from 6 to 8 per cent. of this alkaloid.

Preparation.—Opium which has been exhausted by water in the first stage of the preparation of morphia (p. 753) contains a large quantity of narcotia. It is extracted by acetic acid, precipitating the filtered liquid by ammonia, redissolving the crude narcotia thus obtained by solution in alcohol, and crystallising it. The alcoholic fluid (mother-liquor E) contains most of the papaverine and thebaia.

Characters.—Brilliant, colourless, right rhombic prisms; soluble in 400 parts of boiling, insoluble in cold water; soluble in 100 parts of cold, and in 24 parts of boiling alcohol, more soluble in both æther and in chloroform; insoluble in caustic alkali. It forms soluble, very bitter salts with acids. Under the influence of oxydising agents it forms cotarnia and opianic acid. Meconic is formed by the action of potash on the latter.

Action and Uses.—It is said to be free from the properties which characterise the constituents of opium previously described, and to be merely tonic. As yet I have not examined this body, and have therefore no observations of my own to offer. Dr Roots gave it internally in doses of 20 grains without "injury," but this is equally true of papaverine and narceia. Dr O'Shaughnessy has employed it with success as a substitute for quinine in intermittent fever.

Meconic Acid, $H_3C_7HO_73H_2O$.

Opium contains from 6 to 8 per cent. of this tribasic acid, and exists in the drug in combination with the alkaloids above described.

Preparation.—The meconate of lime separated in the second stage of the preparation of morphia is mixed with 10 parts of water at 190°, and decomposed by the addition of a considerable excess of hydrochloric acid. The meconic acid separates from the solution in scaly crystals.

Characters and Tests.—Colourless micaceous crystals; sparingly soluble in cold water, freely in hot. The aqueous solution is decomposed by boiling with the escape of carbonic acid and the formation of comenic acid. The crystals lose 3 atoms of water at 212°, and are decomposed, as above stated, at 248°. The aqueous solution gives white precipitates (*meconates*) with salts of lime, baryta, and lead; a green one with ammonio-sulphate of copper; and forms a blood-red solution with one of perchloride of iron, like that produced by the addition of the latter to a solution of sulphocyanide of potassium. The presence of meconic acid is ascertained by the formation of this colour, which is not discharged by the addition of zinc and sulphuric acid, nor by a solution of perchloride of mercury, or of auric chloride, all of which discharge the colour of the ferric sulphocyanide. In testing for meconic acid the suspected fluid should be mixed with a solution of acetate of lead. The precipitated meconate of lead is washed, suspended in water, and decomposed by sulphuretted hydrogen. The filtered fluid is concentrated at a temperature below 150°, and then tested as above. The alkaline acetates, which give with the persalts of iron a rich brown colour, are readily distinguished, as they do not give precipitates with salts of barium and lead.

SANGUINARIA CANADENSIS, Blood Root or Red Puccoon.

This plant, which has been an inhabitant of our gardens since the year 1680, is an article of the United States Pharmacopœia. It is a native of the woods of Canada.

Characters.—A stemless herbaceous *plant*, with a large knobby perennial root, internally of a rich orange-red colour, from the presence of a juice which resembles in its characters that of the latex of *Chelidonium majus*. The aerial part of the plant consists of 1 or 2 *scapes* a few inches high, each bearing a solitary white flower, and embraced by 1 or 2 light-greyish reniform *leaves*, deeply lobed, and having very prominent red veins.—*Bot. Mag.* pl. 162.

The rhizome is the part used. It has a bitter acrid taste, and faint heavy odour. The infusion becomes blood-red with sulphuric or hydrochloric acid. It contains a *resin* and a crystalline alkaloid called *sanguinaria* or *chelerythria*, $C_{19}H_{17}NO_4$. It is emetic, expectorant, diaphoretic, and a cardiac depressent. In large doses it is an acrid narcotic.

Uses and Dose.—It is used in acute bronchitis, pneumonia, and pleurisy. In croup and in hepatic congestion the powdered root may be given in doses of 1 or 2 grains; the tincture (1 part of the powdered root to 10 parts of rectified spirit) from ½ to 1 drachm. The alcoholic extract (called sanguinarin—a mixture of the resin and sanguinaria) from ¼ to 1 grain; and the pure alkaloid from $\frac{1}{30}$ to $\frac{1}{10}$ of a grain.

RANUNCULACEÆ, *Decand.* Crowfoots.

This order is distinguished from the Papaveraceæ by the apocarpous fruit and watery acrid juice of the plants. Platystemon, however, amongst the Poppyworts, has an almost syncarpous fruit; while that of Nigella, a crowfoot, is truly syncarpous. Papaveraceæ are at once distinguished by their 2 sepals and 4 crumpled petals, both parts of the flower in Ranunculaceæ exceeding this number.

The Ranunculaceæ abound in acridity, the leaves and roots of many, *e.g.*, *Ranunculus acris* and *R. Flammula*, being rubefacient or vesicant; others, *e.g.*, Hellebore and Podophyllum, are violent irritants, while Aconite furnishes the most virulent of all poisons.

HELLEBORUS NIGER, *Linn.* Black Hellebore or Christmas Rose.

A smooth and shining herbaceous plant, a foot high, with radical leaves and flower stems, and a perennial root. It is a native of the shady woods of the lower mountains of many parts of Europe. It is commonly cultivated in gardens, the handsome flowers expanding at Christmas time.

Characters.—*Root* is black (whence the specific name "niger"), composed of a long horizontal *rhizome* covered with a dark-brown, somewhat scaly epidermis, and a number of vertical rootlets. *Leaves* pedate, of about 5 ovate-lanceolate, coarsely-serrated divisions. *Scape* shorter than the petioles, 1 or 2-flowered, with large oval *bracts*. *Calyx* petaloid, of 5 persistent rounded sepals, at first pure white, or white with a faint pink margin, ultimately becoming green. *Petals* abortive, forming a circle of short tubular glands. *Stamens* 30–60. *Ovaries* 6–8. *Follicles* coriaceous, many-seeded. *Seeds* black, shining, umbilicated.—*Bot. Mag.* pl. 8.

The root is the only part of the plant employed in medicine.

1. **Hellebori nigri radix.** *Black Hellebore Root.*

The dried rhizome and roots (*Goebel and Kunze*, ii. tab. xxxi. fig. 1*a*), imported from Germany.

Characters and Constituents.—The so-called roots consist of the root-stock and of the radicles; the latter are chiefly recommended. The former, some inches long, and half an inch thick, straight or contorted, is marked with transverse ridges, being the remains of the leaf-stalks, and on the under surface with long fibres, all more or less of a dark-brown colour, having internally a white point in the centre. The odour of the dried root is feeble, but has been compared by Geiger to that of Senega root. The taste, at first sweetish, soon becomes bitter and nauseously acrid.

The activity of the root is due to two glucosides, *helleborin* $C_{36}H_{42}O_6$, and *helleborein* $C_{26}H_{44}O_{15}$. The former is the more abundant, but even this exists in minute quantity, about 0·05 per cent. Helleborin is soluble in water and in alcohol, from which it separates in colourless acicular prisms. It is resolved, by boiling with dilute sulphuric acid, into glucose, and helleboresin, $C_{30}H_{38}O_4$. Helleborein, under the same conditions, separates into glucose, and helleboretin, $C_{14}H_{20}O_3$, which is said to be inert.

Adulterations.—These are the roots of *Helleborus viridis*, Linn., which, while they have the same action, are perhaps more potent than those of *H. niger*, and the roots of *Actœa spicata*, Linn. (for the characters of which see p. 780).

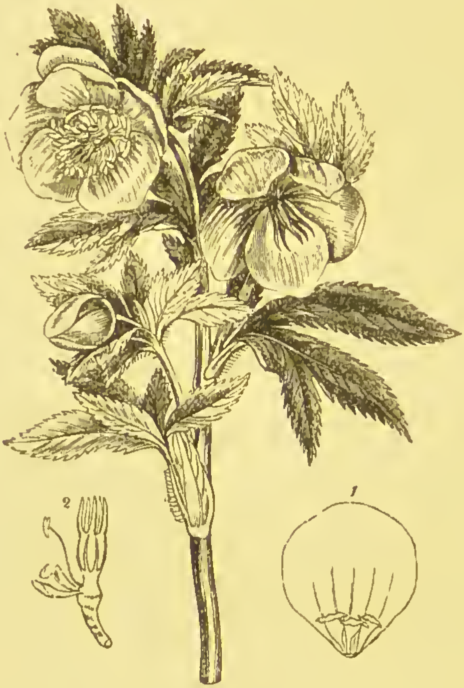

Fig. 133.—*Helleborus officinalis.* 1, Sepal with petals attached; 2, a scale, petal, and stamen, the rest being removed to show the pistils.

Action. Uses.—The fresh root of hellebore applied to the skin induces inflammation and vesication. In excessive doses it causes gastro-intestinal inflammation. In full doses it acts as an irritant, producing vomiting and purging, followed in some cases by inflammation of the rectum and depression of the heart's action. In moderate doses it is purgative and emmenagogue.

Dose.—Of the powder, 10 to 20 grains as a drastic purgative; of the infusion (2 drachms to 10 ounces of boiling water) ½ to 1 ounce;

of the tincture (2½ ounces to 1 pint of proof spirit) ½ to 1 fluid drachm.

Other Species of Hellebore.—The following species deserve notice here:—1. *H. officinalis*, Sibthorp (*Flora Græca*, t. 583). It was found by Dr Sibthorp on hilly ground in Greece, and was considered by him to be the black hellebore of Dioscorides, being still used and called *Zoptima* by the Turks, and Σκαρφη by the Greeks. 2. *H. viridis* and *H. fœtidus*, two indigenous species, the roots of which are as active as those of *H. niger*. The leaves of the *H. fœtidus* possess the same properties as the root, and have been used as an emetic and anthelmintic.

DELPHINIUM STAPHISAGRIA, *Linn.* Stavesacre.

Stavesacre is a native of the south of Europe and of the Mediterranean islands. It has been identified by Dr Sibthorp as that employed medicinally by the Greeks. It is often confounded with *D. pictum* and *D. Requienii*.

Characters.—A biennial, with a herbaceous, softly-pubescent *stem* 2 to 4 feet high, dingy blue. *Leaves* dark-green, broad, palmately 5-9 cleft, segments entire or trifid, pedicels tribracteate at their base. *Flowers*, above, tomentose-pubescent; below, in a lax raceme, with 5 petaloid *sepals*, the upper one shortly spurred. *Petals* 4, united at the base, and beardless, the two upper extended into appendages enclosed within the *spur*, the two lower spathulate. *Capsules* 3, ovate ventricose. *Seeds* numerous.—*Fl. Græca*, t. 508.

The seeds of this plant are alone used.

1. **Staphisagriæ semina.** *Stavesacre Seeds.*

The ripe seeds, imported from Germany and the south of France.

Characters and Constituents.—Irregularly triangular, about ¼ inch long, and not quite so wide. The testa is greyish-brown, rough with wrinkles and pits, and brittle. The kernel is composed of very oily albumin enclosing a minute embryo in the narrow end. The taste is bitter, followed by burning and tingling.

The active properties are due to *delphinia* or *delphinine*, $C_{24}H_{35}NO_2$, which is contained in the shelly covering. The kernel itself contains about 25 per cent. of fixed oil. Delphinia occurs in minute rhombohedra, fusing at 248°, and is nearly insoluble in water. The seeds also contain a second alkaloid called *staphisaïne*, $C_{16}H_{23}NO_2$. It is insoluble in æther; soluble in alcohol, æther, and chloroform, and has an extremely burning acrid taste. It is readily precipitated from its solutions by chromic acid, which combines to form a very sparingly soluble chromate.

Delphinia may be obtained by exhausting an alcoholic extract with boiling water acidulated with sulphuric acid, and then precipitating the alkaloid from the solution by means of ammonia. Or the watery extract may be boiled with magnesia, and the separated precipitate subsequently boiled in alcohol, upon evaporation of which the impure salt is deposited. It may be freed from staphisaïne by solution in æther.

Action. Uses.—Stavesacre seeds and delphinia are acrid poisons; the former are commonly employed to kill pediculi. An alcoholic solution rubbed on the skin produces burning and tingling, and is hence used as a counter-irritant. The seeds have been given as an emetic and cathartic, and also in infusion as an anthelmintic; but it is not a safe remedy for internal use, the action being too violent.

2. **Tinctura *vel* Solutio Delphiniæ.**

Dissolve 40 grains of *delphinia* in 2 fluid ounces of *rectified spirit.* It may be used as an embrocation in neuralgia and chronic rheumatism. The following may be substituted:—

3. **Unguentum Delphiniæ.**

Rub up 30 grains of *delphinia* with 1 drachm of *olive oil* and 1 ounce of *lard.* But the aconite preparations are preferable.

ACONITUM NAPELLUS, *Linn.* Aconite or Monkshood.

This plant is general throughout the cold mountainous districts of Europe. It is also indigenous to England, and may still be found wild in the neighbourhood of Ludlow. It is one of the oldest and commonest plants of the English garden, and is often seen in dangerous proximity to the horse-radish. The ακόνιτον of Theophrastus was a virulent poison. Dioscorides describes three or four kinds, one of which is probably *Aconitum Napellus*, which is still known in the mountains of Italy and Greece as *Aconiton. A. Stoerckianum*, Reich. (*A. intermedium*, Dec., and *A. neomontanum*, Willd.), is supposed to have been the plant first submitted to experiment by Störk in 1762, and is regarded by some as a variety of *A. paniculatum.*

Characters.—A smooth and shining *herb*, the perennial root yearly throwing up several erect *stems*, which attain the height of 4 or 5 feet, and terminate in a long spicate raceme of bright blue flowers, which are characterised in all the genus, but particularly in this plant, by the helmet-shaped or cowl-like upper sepal. *Leaves* with 5 wedge-shaped lobes, cut into linear segments. *Calyx* of 5 petaloid sepals, the upper helmet-shaped. *Petals* 5, three inferior, small, and often abortive, and two superior, on long stalks, contained within the helmet, where they curve forward, and end each in a little sac. *Follicles* 3, rarely 5, smooth. *Seeds* black, numerous, smooth, wrinkled.—*Woodv. Med. Bot.* pl. 6.

The root, leaves, and flowering tops are prescribed in the Pharmacopœia, all parts of the plant being replete with the active principle. The seeds are especially potent. Some fatal cases of poisoning have lately occurred in consequence of this root having been scraped and served up at table in the winter time in mistake for horse-radish. A pinkish colour is soon developed at the edge of the scrapings, and the want of pungency in the taste, with the rapidly produced tingling of the tongue, should serve as warnings.

1. **Aconiti radix,** *P.B. Aconite Root.*

The dried root of the plant above described. Imported from Germany or cultivated in Britain, and collected in winter or early spring, before the leaves have appeared (*Pharm. Journ.* vol. xv. p. 452, with fig.)

The specific name *Napellus* has been conferred from a resemblance of the root to the Napus or *Navet*, the French turnip.

Characters and Constituents.—Usually from 1 to 3 inches long, not thicker than the finger at the crown, tapering, blackish-brown, internally whitish. A minute portion chewed causes prolonged tingling and numbness in the mouth.

The essential constituent of the root, and that which produces the effects just mentioned, is *aconitia*, *aconitina*, or *aconitine* $C_{30}H_{47}NO_{17}$. According to Broughton (*Year Book*, 1874, p. 507), the root contains another base, *atisia* or *atisine*, $C_{46}H_{74}N_2O_5$, which melts at 185°, and forms crystallisable salts with difficulty. Messrs T. and H. Smith of Edinburgh have isolated another crystalline body identical with narcotia, and have called it *aconella*. Aconitia exists in both the amorphous and crystalline forms. That prescribed in the Pharmacopœia is the amorphous variety. English aconitia is derived from the root of *A. ferox*, and differs slightly in its chemical characters from the alkaloid furnished by *A. Napellus* (see p. 777). Acotinia is combined in the root with *aconitic* or *equisetic acid*, $H_3C_6H_3O_6$ (see Citric acid, p. 659).

2. **Aconitia,** *P.B.* *Aconitia.* $C_{30}H_{47}NO_7$, Planta. $C_{54}H_{40}NO_2$, Duquesnel. $C_{32}H_{43}NO_{10}$, C. R. A. Wright.

These different formulas are given in order to show that chemists are not in agreement as to the composition of the alkaloid derived from *Aconitum Napellus*. The alkaloid is directed to be prepared from the root by the following process:—

Preparation.—Pour 3 gallons of *rectified spirit* upon 14 pounds of *aconite root* in coarse powder, mix and heat to the boiling point; then cool and macerate for four days. Transfer the whole to a displacement apparatus (fig. 8, p. 21) and percolate, adding more spirit when requisite, until the root is exhausted. Distil off the greater part of the spirit from the tincture, and evaporate the remainder over a water bath until the whole of the alcohol has been dissipated. Mix the residual extract thoroughly with twice its weight of *boiling water*, and, when it has attained the temperature of the atmosphere, filter. To the filtered liquor add *solution of ammonia* in slight excess, and heat gently over a water bath. Separate the precipitate on a filter, and dry it. Reduce this to coarse powder, and macerate it in successive portions of pure æther with frequent agitation. Decant the several products, mix, and distil off the æther until the extract is dry. Dissolve the dry extract in warm water acidulated with the *sulphuric acid*, and, when the solution is cold, precipitate it by the cautious addition of *solution of ammonia* diluted with four times its bulk of distilled water. Wash the precipitate on a filter with a small quantity of cold water, and dry it by slight pressure between folds of filtering paper.

A spirituous extract of the root is first obtained, free from starch and other vegetable matters insoluble in rectified spirit. Resinous matters are separated by solution in water and filtration. The water then contains the aconitate of aconitia. Ammonia is added, which combines with the aconitic acid, and as the quantity of water used this time was only twice the weight of the extract, most of the aconitia is precipitated. The precipitate is dried. Any ammoniacal salt adherent, and certain other impurities, are separated by the æther, in which they are insoluble. "The æthereal extract, which is nearly pure aconitia, will be diminished in quantity, if not altogether lost, in the concluding part of the process. It is dissolved in acidulated *warm* water, but the quantity of water is not stated. Now, supposing the dry root to contain as much as 20 grains of the alkaloid in the pound, 14 pounds ought to yield 280 grains. This amount is soluble in 50 parts of hot water, so that 1½ pint (or 4½ pints cold) will dissolve the whole of it, and the addition of ammonia to that quantity of solution will produce no result whatever. When the root is poor in alkaloid, as often happens, a much smaller quantity of water will retain the aconitia. In any case the loss is great, unless the water is used on a limited scale" (Headland).

The average produce of the root *collected after flowering* and fresh, is 8·58 grains of aconitia in the pound; of the same dried, 35·72 grains. But if *collected before flowering*, the yield is only 3·5 grains per pound in the fresh, and 12·13 in the dried root (Herepath). These results are the average of several experiments. From French aconite root M. Hottot has obtained an average of 4 grains in the pound (*Journ. de Pharm.* April 1864). The root of *A. ferox* contains about three times as much alkaloid as that of the English plant.

Characters and Tests.—Aconitia is a white, usually amorphous solid, soluble in 150 parts of cold and 50 of hot water, and much more soluble in alcohol and in æther; strongly alkaline to reddened litmus, neutralising acids, and precipitated from them by the caustic alkalies, but not by carbonate of ammonia or the bicarbonates of soda or potash. It fuses at about 200°, and when strongly heated burns with a smoky flame, leaving no residue when burned with free access of air. When rubbed on the skin it causes a tingling sensation, followed by prolonged numbness. It is a very active poison.

Morson of London, T. and H. Smith of Edinburgh, and Duquesnel (*Comptes Rendus*, vol. lxxiii. 1864), have obtained the alkaloid in a crystalline form. It is stated, I know not upon what authority, in Pereira's *Elements of Materia Medica*, by Bentley and Redwood, p. 1000, that crystalline àconitia is much weaker than the amorphous variety. This from my observations I can affirm is not the case. In one experimant a horse had a narrow escape from death after the subcutaneous injection of the $\frac{1}{24}$th of a grain of Morson's crystalline aconitia (*St Thomas's Hosp. Rep.* 1874); and I have found the crystalline alkaloid, as prepared by Messrs Morson from *Aconitum ferox*, and that prepared by Messrs T. and H. Smith of Edinburgh from *A. Napellus* grown in Morayshire, or in the vicinity of Edinburgh, so exactly similar in action and potency that it appears to me very desirable the Pharmacopœia should prescribe directions for the preparation of the crystalline variety of aconitia, for it is well known that amorphous aconitia, and notably that obtained from Germany, is very impure; indeed, Husemann regards it as less active than the extract! The use of a preparation of this kind may lead to the most dangerous results, by engendering false impressions as to the dose of the pure alkaloid. Both Morson's and Smith's aconitia is very pure, that of the former maker occurs in colourless right rhombic prisms. Messrs Smith have supplied me with the nitrate in good crystals, and they also prepare a crystalline sulphate and hydrochlorate.

So long as the pure alkaloid can be obtained the other preparations of aconite are not only superfluous but mischievous, for it is impossible to prepare them from year to year of uniform strength.

Action.—If a crystal be quickly passed over the tip of the tongue, or a drop of a solution containing the $\frac{1}{1000}$ part of the alkaloid be placed in the mouth, a numbing, tingling sensation is speedily developed, spreads over the tongue and fauces, increases in intensity at the end of about three hours, and then gradually fades away during the next three hours. The $\frac{1}{200}$ of a grain, taken in the form of a diluted solution by the mouth, causes a little somnolency after an hour, with slight tingling in the mouth and face, these symptoms continuing for two or three hours more. The $\frac{1}{175}$ of a grain produces a faint glowing sensation throughout the body in addition to the foregoing effects. The $\frac{1}{150}$ to the $\frac{1}{100}$ of a grain converts the glowing feeling into a numbing glow,—a comfortable feeling as if sleep were coming on, and followed by actual somnolency. The effects obtain their maximum in two hours, and do not wholly pass off until the expiration of five or six hours after the dose. The $\frac{1}{50}$ of a grain produces very decided *aconitism.* In addition to the general numbing and tingling, which is always most marked in the upper parts of the body, the patient is oppressed with somnolency and languor, but sleep is broken by uneasy sensations of oppression in the præcordial or diaphragmatic regions. He is unable to walk across the room without assistance, the vision is dim and hazy, the erect posture induces giddiness and nausea, there is a burning sensation in the throat, and dysphagia. The giddiness, dimness of vision, and muscular weakness, are most marked between the sixth and the tenth hours.

Aconitia, when given by subcutaneous injection, produces the same symptoms, but they are more speedily developed, and the puncture is the seat of burning irritation. The $\frac{1}{200}$ of a grain is the maximum dose, being equivalent to the $\frac{1}{50}$ of a grain by the mouth. This is sufficient to kill a moderate-sized dog, and the $\frac{1}{24}$ of a grain given subcutaneously is nearly sufficient to kill a horse.

In producing the effects above detailed, and those which follow poisonous doses, aconitia acts as follows:—

1. It affects the roots of both the motor and sensory nerves which

arise from the medulla oblongata, producing intermittent suffocative spasm by its action on the former, and anæsthesia of the head and neck by its influence on the latter.

2. Beyond the limits of the medulla aconitia exercises a general depressing influence on the motor and sensory function, almost amounting to paralysis of the lower part of the body, with diminished sensation.

3. Excepting taste, which is more or less completely abolished, the special senses are not directly affected, but from interference (spasm or palsy) of the accommodating apparatus, the vision is dim, and the hearing may be modified. The pupil may be slightly dilated, or in the severer forms of poisoning contracted.

4. The brain is unaffected.

5. The heart is only secondarily affected by an almost continual restraint on the breathing, but especially by the suffocative spasms, during which the right cavities become enormously engorged, and the left ones nearly empty.

6. Death results from asphyxia and progressive collapse of the lung,—the former being due to spasmodic closure of the respiratory passages and paralysis of the muscles of inspiration, and notably of the diaphragm. If, however, the heart be weakened by disease, it may be unable to bear the strain imposed by obstructed inspiration, and death would then result from syncope (see a paper by the editor, *St Thomas's Hosp. Rep.* vol. v. new ser. 1874).

Antidotes.—No chemical antidote is known. Animal charcoal is recommended by Dr Headland, but this is a weak reed to lean upon. A mustard emetic should be administered, followed by the use of the stomach-pump, by means of which the stomach should be washed out. In the latter stages, depletion from a jugular vein to relieve the distension of the right heart, accompanied by the most persevering efforts to promote the expansion of the chest. With this object we should employ gentle magneto-electric currents down the back of the neck and around the margin of the ribs, to excite contractions of the diaphragm, and over the pectoral muscles; with rhythmical abductions of the upper extremities. If the patient can swallow, brandy and ammonia should be given.

Medicinal Uses.—Aconite, by its primary depressing effect on the respiration, lowers both the temperature and the pulse, it is therefore employed in febrile affections. Its influence in scarlatina and typhus is not very marked, but it is especially adapted for the treatment of rheumatic fever, in which disease it is undoubtedly a useful remedy. In neuralgia, due to irritation of the fifth nerve, aconitia is often very serviceable; it may be given internally or applied to the surface of the skin. In sciatica its good effects are not very marked, indeed the anæsthesiant action, on parts so distant from the medulla, is, for medicinal doses at least, very weak, nor have I obtained any very favourable results from local subcutaneous injection.

Dose.—From the $\frac{1}{400}$ to the $\frac{1}{50}$ of a grain by the mouth. The first mentioned dose may be given to a child five years of age once a day, and to an adult two or three times a day; but doses above the $\frac{1}{100}$ of a grain should not be repeated until after an interval of thirty-six or forty-eight hours, for the alkaloid is very slowly eliminated or decomposed, and $\frac{1}{50}$ of a grain will cause effects which may be felt for twenty-four hours. Subcutaneously injected, the dose for an adult should not exceed the $\frac{1}{200}$ of a grain. The following solution may be employed. I have kept it unchanged for four years:—Aconitia, 1 grain; acetic acid, 1 minim; rectified spirit, 2 fluid drachms; water to measure 2000 grain measures. 10 minims = $\frac{1}{200}$ of a grain. This solution may also be used as an outward application, 30 drops being applied by means of a piece of lint covered with oiled silk to the painful part until numbness is produced. The following is the only authorised form for the use of aconitia:—

2. **Unguentum Aconitiæ**, *P.B.* *Ointment of Aconitia.*

Preparation.—Dissolve 8 grains of *aconitia* in ½ fluid drachm of *rectified spirit*, and mix thoroughly with 1 ounce of *prepared lard.* This ointment is dangerously strong, and must be used with extreme caution. A portion the size of a nut may be rubbed on the painful skin until numbness is produced; it should then be carefully wiped off. The numbness increases, and may continue for eight or fourteen hours. It is chiefly employed in neuralgia of the face.

3. **Linimentum Aconiti**, *P.B.* *Liniment of Aconite.*

Preparation.—Moisten 20 ounces of *aconite root* in coarse powder with *rectified spirit*, and macerate for three days; then transfer to a percolator, add rectified spirit, and percolate slowly into a receiver containing 1 ounce of *camphor* until the product amounts to 1 pint.

A strong preparation for outward use. It is of great utility as a local anodyne in tic douloureux and other painful affections. It must not be applied where there is any sore or abrasion of the skin, nor should it be rubbed on or near the mouth. It may be applied with the finger, a sponge, or tooth-brush, until numbness is produced.

4. **Tinctura Aconiti**, *P.B.* *Tincture of Aconite.*

Preparation.—Macerate 2½ ounces of *aconite root* in coarse powder for forty-eight hours in 15 fluid ounces of *rectified spirit* in a close vessel, agitating occasionally; then transfer to a percolator, and when the fluid ceases to pass pour into the percolator the remaining 5 fluid ounces of the spirit. As soon as the percolation is completed, subject the contents of the percolator to pressure, filter the product, mix the liquids, and add sufficient rectified spirit to make *one pint.*

It is beautifully transparent, of the colour of sherry wine; the taste is slightly bitter, followed by a sensation of tingling and numbness.

Dose.—5 to 15 minims, and only to be very gradually, if at all increased.

"Fleming's Tincture," which is kept in the shops and preferred by some prescribers, must on no account be given in the above doses. It is nearly four times stronger than the tincture of the Pharmacopœia. The strength, however, of both varies according to the quantity of alkaloid contained in the root employed. Sometimes the tincture is nearly inert, the root having been imperfectly dried or improperly preserved; on the other hand, it is sometimes unusually potent.

5. **Extractum Aconiti**, *P.B.* *Extract of Aconite.*

Preparation.—Bruise 112 pounds of the *fresh leaves* and *flowering tops of aconite* in a stone mortar, and press out the juice; heat it gradually to 130°, and separate the green colouring matter by a calico filter. Heat the strained liquor to 200°, to coagulate the albumin, and again filter. Evaporate the filtrate by a water bath to the consistence of a thin syrup; then add to it the green colouring matter previously separated, and, stirring the whole together assiduously, continue the evaporation at a temperature not exceeding 140°, until the extract is of a proper consistence for forming pills.

In this process the albuminous matter, which has a tendency to ferment, is removed. The chlorophyll is retained to give the bulk and colour desired. The resulting extract is somewhat more active than the old extract, but variable in strength, as are the leaves from which it is obtained.

Dose.—1 to 2 grains.

OTHER SPECIES OF ACONITUM.—Most of the species of aconite contain aconitia. According to Schroff (*Journal für Pharmacodyn.* 1857, p. 385), the following is the order of the plants according to their virulency:—*A. ferox*, *A. Napellus*, *A. neomontanum*, *tauricum* et *variabile*, *A. Cammarum*, *A. paniculatum*, *A. Anthora.* He states that the toxic properties of the *A. Anthora* are very weak. Dr Fleming has proved that the *A. paniculatum* (formerly prescribed in the London and Dublin Pharmacopœias) is comparatively inert. Royle and Headland state that *A. heterophyllum*, an Indian species, possesses tonic properties, and is not poisonous. Dr Hooker states (*Flora Brit. India*) that the roots of *A. multifidum* and *A. rotundifolium* are edible. The leaves of *A. septentrionale*, Koelle, a variety of *A. lycoctonum*, Linn., with blue flowers, is eaten as a pot herb. It appears, however, that these plants do contain minute proportions of an active constituent, for Schroff, jun., obtained a very poisonous alkaloid from the root of *A. septentrionale.* Of the species of aconite the Indian species, *A. ferox*, is the most valuable, since it contains at least three times as much aconitia as *A. Napellus.* It is, indeed, the source of English aconitia, and therefore requires a brief notice.

ACONITUM FEROX, Wallich, *Nepal Aconite.*

Bikh or *Bish.* Arab. *Bisch.* Sansk. *Visha* or *Ativisha.*

This is a native of the subalpine Himalayas, from Garwhal to

Sikkim, growing at an elevation of 10,000 to 14,000 feet in company with *A. Napellus*, *A. luridum*, Hooker and Thomson, *A. palmatum*, Don, and *A. uncinatum*, all very poisonous species. It grows to the height of 4 or 6 feet, and has large dull-blue flowers. The root is thick, tap-shaped, and without rootlets; brown outside and white within. There are two different kinds, which may easily be separated by sorting. One, which appears to be collected about the commencement of the Himalayan season, is heavy, of a dense horny texture, and contains a large quantity of starch. The other is light and friable, with a powdery or farinaceous structure. It seems to contain the same amount of alkaloid, bulk for bulk, as the other kind, and being of less specific gravity, is the more valuable of the two. Dr Headland found in several experiments, the results of which were very uniform, that while from 54 to 56 grains of aconitia could be obtained from 1 pound of the horny root, 88 to 92 grains were extracted from a pound of the friable root. The proportion is about 3 to 5.

The variety of aconitia obtained from this plant has been very improperly termed *pseud-aconitine* or *pseud-aconitia*. It is otherwise distinguished as *English aconitine; napelline* (Wiggers), *nepaline* (Flückiger), and *acraconitine* (Ludwig). According to C. R. Alder Wright, its composition is $C_{36}H_{49}NO_{11}$ (*Pharm. Journ.* Sept. 1875, p. 190). In the perfection of crystalline form, in potency of action (see Aconitia), and in the possession of the peculiar attributes of *Aconitum Napellus*, it must undoubtedly be regarded as the most perfect form of the alkaloïd, which, it appears, is very susceptible of variation under the influence of chemical reagents.

PODOPHYLLUM PELTATUM, *Linn.* The May Apple.

The genus Podophyllum is the connecting link between the Ranunculaceæ and the Berberidaceæ, and is placed by botanists in either family. The species under consideration is common in moist, shady spots along the eastern side of North America from Hudson's Bay to Florida.

The pulp is acidulous, and is sometimes eaten.

Characters.—A perennial herbaceous plant of singular appearance. The *root* is chiefly composed of a creeping horizontal rhizome. The *stem* about 1 foot high, and bearing only two very large peltate *leaves*, subdivided into 5 or 7 wedge-shaped lobes, and a large solitary terminal white nodding flower. *Sepals* 3, caducous. *Petals* obovate, 6–9. *Stamens*, 16–18. *Stigma* large, sessile. *Fruit* pulpy, yellowish, about the size of a pigeon's egg, 1-celled; *seeds* 12, imbedded in acidulous pulp.—*Bot. Mag.* pl. 1819.

The root is the part used in medicine.

1. Podophylli radix, *P.B.* *Podophyllum Root.*

The root of the plant above described, imported from North America.

Characters.—In hard brittle pieces of variable length, from about two to four lines thick, smooth or faintly wrinkled longitudinally, reddish-brown externally, whitish within, breaking with a short smooth fracture; presents, at intervals of 3 or 4 inches, a knotty joint with a depressed scar marking the origin of a fallen stem, and furnishing at this part a few paler brown rootlets about half a line thick. The powder is yellowish-grey, of sweetish odour, and bitterish, subacrid and nauseous taste. The dried root yields from 3½ to 5 per cent. of *resin*, called *podophyllin*. It is to this that the root owes its activity. It also contains a considerable amount of *berberine*, a bitter crystalline alkaloid destitute of cathartic properties; an *odoriferous principle* which sublimes in colourless scales, and *saponine* (F. F. Mayer). The active principle, being a resin, is of course completely soluble in alcohol.

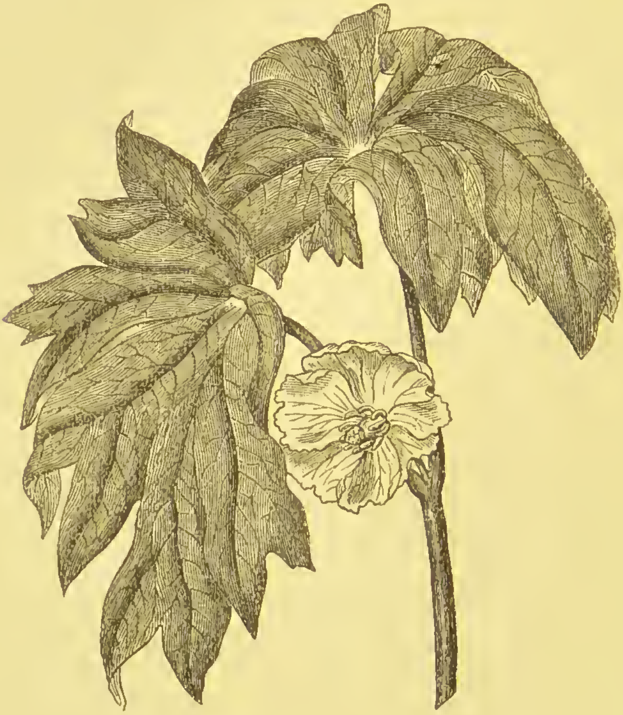

Fig. 134.—*Podophyllum peltatum.*

Action and Uses.—A hydragogue purgative. (See Resina podophylli.)

Dose.—Of the powdered root, 10 to 20 grains.

2. **Podophylli resina**, *P.B.* *Resin of Podophyllum* (“*Podophyllin*”).

Preparation.—Exhaust 1 pound of *podophyllum root* in coarse powder by interrupted percolation with 3 pints, or a sufficiency of *rectified spirit;* place the tincture in a still, and draw off the greater part of the spirit. Slowly pour the liquid (about 6 fluid ounces) which remains into three times its volume of *water* acidulated with $\frac{1}{24}$ of its bulk of *hydrochloric acid*, constantly stirring. Allow the mixture to stand for twenty-fours to deposit the resin. Wash this on a filter with water, and dry it in a stove.

Rectified spirit dissolves the whole of the active resin, together with the berberine and other principles. The object of acidulating the water is to facilitate the separation of the resin, and cause its deposition in the form of powder. The subsequent washing removes the berberine and saponine which are precipitated with the resin. The latter should be dried at a temperature not exceeding 89°, otherwise it becomes dark brown.

Credner states that æther precipitates from the alcoholic solution a resin of greater activity than the whole. Dr Manlius Smith states that the resin when pure is white. Anyhow, the process above adopted separates the whole of the active principle.

Characters.—A pale greenish-brown amorphous powder, soluble in rectified spirit and in ammonia, precipitated from the former solution by water, from the latter by acids. Almost entirely soluble in pure æther.

The alcoholic solution has a strong heavy odour, and a bitter taste.

Action and Uses.—It is an irritant to the mucous membrane. A minute particle, brought in contact with the eye or the nose, causes local inflammation for a few hours. A drop of the alcoholic solution (1 part in 15), placed on the tongue and swallowed, caused in the course of half an hour redness and soreness of the fauces, and a subacrid sensation on the palate and tongue, the latter feeling as if it had been scalded. After ten hours the soreness of the throat attained its maximum, and was attended with a little increase of secretions as occurs in slight catarrh; the numbing, scalding sensation had spread over the anterior half of the tongue, and blunted taste. Next day the throat was well, but the condition of the tongue was worse, the disorder of sensation was increased both in degree and extant, and taste was nearly abolished, except at the hinder part of the tongue and palate. This continued for more than twenty-four hours after the experiment was made, and the effects were still appreciable after forty-eight hours. In large doses, by the stomach or skin, it produces violent gastro-intestinal irritation, and its results, vomiting, hypercatharsis, with colicky pains and sometimes bloody stools, tenesmus, and prolapsus ani, with prostration. In moderate doses it is an active cathartic. According to American practitioners it is certain in its action, and has been found so useful in hepatic complaints that it has obtained the name of "Vegetable Calomel." I have not found it to be so certain in its effects as jalap; and am inclined to regard its action on the liver simply as a consequence of intestinal irritation. It is useful in hepatic congestion as a means of relieving fulness of the abdominal veins, in constipation dependent upon defective secretion from the general mucous surface; and generally when brisk catharsis is desirable. Its use is positively contraindicated in inflammatory affections of any part of the alimentary canal, for its action is slower, more persistent, and more acrid than that of most other cathartics.

Dose.—$\frac{1}{4}$ to 1 grain. It should be given in the form of powder, and the particles separated by admixture with sulphate of potash, by which means its action is rendered both more certain and rapid.

ACTÆA RACEMOSA, *Linn.* Black Snake Root, Cohosh, Bugbane.

Synonym.—*Cimicifuga racemosa*, Torrey and Grey.

Characters.—A perennial herb, growing in the North American woods as far south as Florida, and greatly resembling our indigenous *Actæa spicata*, but differing in having a dry follicle instead of a juicy berry.

The stem is 3 to 5 feet high. The leaves are somewhat ternate, and the leaflets are coarsely serrated or incised. The flowers whitish, in long branched spicate racemes.

Radix Actææ racemosæ. *Cimicifuga.*

This is officinal in the United States Pharmacopœia. The root is dark brown, of bitter acrid taste, and heavy odour; it is composed of short, knotty, twisted rhizomes about half an inch thick, and from one to three or four inches in length. They present the remains of ascending stems or the projections from which they arise, and the scars from which others have separated; and in the other direction numerous wiry, brittle rootlets, to some of which other secondary rootlets are attached. A transverse section exhibits a central pith, with broad radiating plates subdividing the small cord of wood into 3–5 wedges, which give a characteristically stellate appearance; and a thick, dark, brittle cortex; the whole exactly resembling the structure and appearance of the roots of *Actæa spicata.*

The active principle is due to a resinous principle which has been termed *cimicifugin* or *macrotin*, a dark brown powder, readily soluble in alcohol. It is prepared from the concentrated tincture by the addition of water. The root yields about 4 per cent. Conard obtained a neutral crystalline principle of acrid taste, and soluble in alcohol, æther, and chloroform (*Amer. Jour. Pharm.* xliii. 1871).

Action and Uses.—In action it resembles hellebore on the one hand and colchium on the other, full doses causing vomiting, relaxation of the bowels, giddiness, and headache, attended by reduction of the pulse. Its beneficial effects are best illustrated in acute rheumatism. Some practitioners regard it as a stimulant expectorant.

Dose.—The powder of the fresh root is perhaps the best form of using the drug. It may be given in doses of 20 to 30 grains. A fluid extract, one minim of which represents a grain of the powdered root, is used in America, and is regarded as an efficient preparation. The tincture, prepared as Tinctura hellebori, may be employed.

HYDRASTIS CANADENSIS, *Linn.* Yellow Root.

Characters.—A small perennial herbaceous plant of the Anemone subdivision of the Ranunculaceæ. The stem is erect, a foot high, provided usually with only two broad palmi-lobed leaves, and a solitary terminal flower. The achenia are drupaceous and crimson.

Radix Hydrastis Canadensis. *Hydrastis Root.*

Yellow root is an article of the United States Pharmacopœia. It is a knotted tortuous rhizome with a number of fine rootlets. The colour internally is deep yellow; the odour strong and heavy, and the taste intensely bitter. It contains about 1½ per cent. of an active principle called *hydrastin.* Mehla (*Silliman's Amer. Jour.* vol. lxxxvii.) obtained it in white glistening four-sided rhombic prisms, alkaline, almost insoluble in water, but freely soluble in alcohol, æther, and chloroform. The solutions are very bitter.

Action and Uses.—It is a pure bitter tonic, and in excessive doses produces symptoms resembling cinchonism. It is employed as a tonic and antiperiodic.

Dose.—Of the alkaloid hydrastin, from 1 to 2 grs. Of the tincture (root 1 part, rectified spirit 4 parts), 20 to 60 minims.

MAGNOLIACEÆ, *Dec.* The Magnolia Family.

These plants resemble shrubby Crowfoots, from which they are distinguished by the presence of stipules, and in possessing aromatic in place of acrid properties. The leaves sometimes contain the aromatic principle in glandular dots.

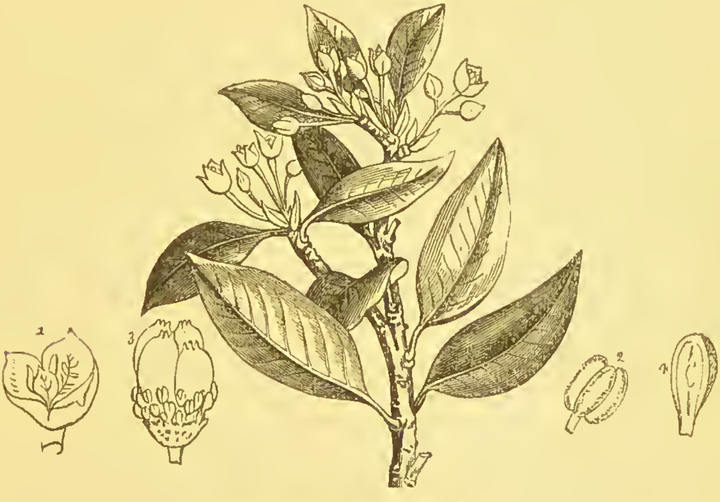

Fig. 135.—*Drimys Winteri.*

The species occur in a scattered manner in America, China, Japan, New Holland, and New Zealand. The *Star-Anise*, a fruit so called from being arranged in a stellate manner, and having the taste and odour of anise, is well known in the East by the name of *Badian.* Star-anise is the fruit of *Illicium anisatum*, a native of China. The bark of *Michelia gracilis* smells strongly of camphor. The bark of *Magnolia glauca* is very bitter and aromatic, and is said to resemble, and even rival, cinchona in its action.

DRIMYS WINTERI, *Dec.* Winter's Cinnamon.

Winter's Bark is the produce of this tree. It was first brought to Europe by Captain Winter, after a voyage to the Straits of Magellan, in 1579. On account of its aromatic and stimulant properties, it has been used as a substitute for cinnamon. In properties it resembles Canella bark, with which it has been confounded. It is now seldom employed.

ILLICIUM ANISATUM, *Loureiro.* Star-anise.

This is a tree about twenty feet high, a native of the south-western provinces of China. Siebold found it planted about the Buddhist temples in Japan, whence he named it *I. religiosum.* The fruit is esteemed on account of the volatile oil. It is composed of 8 one-seeded carpels, which in ripening spread out into a whorl around a short central column. This fruit is reddish-brown, wrinkled, and each carpel is slightly beaked. The seed is not aromatic, but the carpel has a pleasant aromatic taste, intermediate between fennel and anise, due to volatile oil, of which the carpels contain 4 or 5 per cent. This volatile oil is indistinguishable from that of oil of anise (see p. 579), for which it is often substituted.

ANIMAL MATERIA MEDICA.

The animal creation, so interesting and essential an object of study for acquiring a scientific knowledge of the anatomy and physiology of the human frame, has become less important as connected with Materia Medica since the progress of medicine has eliminated from our books and practice a crowd of inert and disgusting remedies, which could only have operated through the imagination; while modern chemistry has shown that others, such as corals, burnt oyster shells, crabs claws, burnt bone, and burnt sponge, can be obtained more easily and as pure from the mineral or vegetable kingdom.

The peculiar secretions, musk and castor, still retain a place in the Pharmacopœia.

PORIFERA, *Grant.* Sponges.

SPONGIA OFFICINALIS, *Linn.* The Sponge.

The peculiar, soft, elastic skeleton of this animal constitutes ordinary sponge. The finest kind (*Turkey sponge*) is imported from the Mediterranean and the Red Sea. The coarser kind (*West Indian* or *Bahama sponge*) is obtained from the West Indies.

Turkey Sponge occurs in cup-shaped masses of finely reticulated tissue, composed, according to Hatchett, of *gelatine* and *coagulated albumin.* The ash is composed of silicate, phosphate, carbonate, chloride, and iodide of sodium, calcium, and magnesium, with a little oxyde of iron. Before it is used, sponge contains numerous fragments of corals and minute shells, and often a good deal of fine sand. These must be removed by soaking and squeezing.

Uses.—The common use of sponge is familiar to every one. It is employed to absorb blood in surgical operations and to dress wounds; but it should properly be restricted to the first of these uses. Its repeated use in dressing wounds is not cleanly, and if the same piece of sponge be used for several patients, there is risk of conveying infection. Nor should the same sponge be used for a second operation until it has been thoroughly cleansed by prolonged maceration in cold water containing a little carbolic acid. *Sponge tents* are useful for dilating the natural passages of the body, such as the female urethra, the os uteri, and sinuses. They are prepared by soaking a flat piece of sponge in melted wax, and while still warm rolling it as tightly as possible into a conical plug with a fine end, and rolling it round with thick twine until it is cold, and then removing the twine, and immersing the tent for a second in melted wax, so as to cover it with a smooth waxy layer. When a tent of this kind is placed in a passage of the body the wax melts, the sponge slowly absorbs moisture, and in swelling dilates the part in which it is inserted.

Burnt sponge contains iodine (see p. 75), and is still given in doses of 1 drachm, mixed with honey, in goïtre and scrofulous swellings.

ANNELIDA. Worms.

SANGUISUGA. The Blood-sucking Leech.

Leeches and their effects must have been known from the earliest times. They were early employed therapeutically by the Hindoos, and the Arabs adopted their practice (Royle, *Hindoo Med.* p. 38; and Wise on *Hindu Medicine*, p. 177). Themison mentions the employment of leeches by the ancients. Herodotus alludes to one kind (*Bdella Nilotica*). Dr Pereira infers that *Sanguisuga Ægyptiaca*, the species from which the French soldiers in Egypt suffered, is that referred to in the Bible (Prov. xxx. 15) by the name of *Olukeh* or *Aluka.* The latter, or *Aluk*, is also the Arabic name for leech.

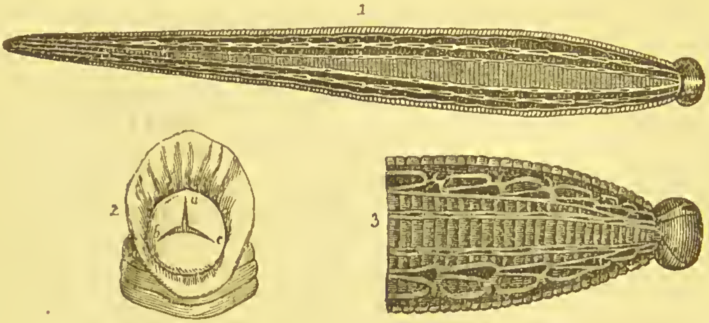

Fig. 136.—*Sanguisuga medicinalis.*

Generic Characters.—Body elongated, plano-convex, tapering towards both extremities, wrinkled transversely, and composed of from 90 to 100 soft rings. The *mouth* is furnished with a lip, and the posterior extremity provided with a flattened disk, both adapted to fix upon bodies by suction, and to serve as organs of prehension and locomotion. Underneath the body two series of *pores* are observed, which lead to as many interior *respiratory sacs.* The *intestinal canal* is straight, inflated from space to space, as far as two-thirds of its length, where there are two cæca. The blood swallowed is preserved there red and unchanged for many weeks; the upper lip divided into several segments; aperture of mouth tri-radiate, and contains *three jaws.* each armed on its edge with two ranges of very fine teeth. Ten blackish points (*ocella*) are observed on the head. The *anus* is small, and placed on the dorsal surface of the last ring.

Hirudo, *P.B. The Leech.*

1. *Sanguisuga medicinalis*, Savigny, the Speckled leech; and 2. *S. officinalis*, Sav., the Green leech. Collected in Spain, France, Italy, and Hungary.

1. S. MEDICINALIS (fig. 136). Belly yellowish-green, covered with black spots, which vary in number and size, forming almost the prevailing tint of the belly, the intervening spaces appearing like yellow spots. On the back

are six longitudinal reddish or yellowish-red bands, spotted with black, and placed on an olive-green or greenish-brown ground. The number of rings varies from 93 to 108. Teeth 79 to 90 in number. A native of almost all parts of Europe, often called the English, the speckled, the true, the brown leech, &c.

2. S. OFFICINALIS is distinguished by its unspotted olive-green belly and by the dark-green back, along which and the flanks are observed six longitudinal, often interrupted, rusty-red stripes. Six of the eyes are said by Savigny to be very prominent. Teeth about 70 in number. A native of the south of Europe, France, and Germany. It is usually called the Green leech, sometimes the Hungary leech, being a native of that country.

Other species are figured by Brandt, as *Hirudo provincialis*, *H. Verbana*, *H. obscura*, and *H. interrupta.* In the United States they use *H. decora.* In India leeches are extremely abundant, procurable both in the tanks of Bengal and in the North-West Provinces, as well as along the foot of the Himalayas. Six kinds of useful and six venomous leeches are mentioned in Susruta and by Avicenna, *l. c.* Leeches are now mostly imported into this country from Hamburg. Many attempts have been made to rear the officinal leech artificially, but they have mostly failed. Those made by M. Soubeiran and others in the ponds in the neighbourhood of Paris were entirely frustrated by the *Oniscus aquaticus*, a small aquatic crustacean, which preys upon the young leeches. The putrefaction of the water in which leeches are kept may be prevented by allowing fragments of iron to remain in it.

Uses.—Leeches are effectual for the local abstraction of blood, affording, indeed, the best method in many cases, as in inflammation of the abdomen, scrotum, in hæmorrhoidal tumours, and prolapsus of the rectum. When applied to the mouth or cervix uteri, they should be retained within a tube (*leech-glass*) or speculum. The surface to which they are applied should be washed, and if need be wetted with a little milk, sugared water, or blood. They act by a sawing motion, and draw each from 1 to 2 drachms of blood, though 4 drachms may be obtained by subsequent fomentation. Excess of bleeding may be stopped by pressure or the application of cotton wool; sometimes it is necessary to apply the stronger solution of perchloride of iron or nitrate of silver; and if the hæmorrhage be uncontrolled by these, the actual cautery.

The leech should be allowed to fill itself and drop off, and then, excepting when the blood is very thin, it will usually be desirable to encourage further oozing by hot fomentations. If a leech should inadvertently obtain access to the rectum or the stomach, a strong solution of salt should be immediately injected in the one case and swallowed in the other.

INSECTA.

BLISTERING BEETLES.

The name κάνθαρις was applied by the Greeks to a species of Coleopterous insect which possessed the properties of the prescribed Blistering Beetle; but it was distinguished by *yellow* transverse bands. This is the characteristic of the species of Mylabris, one of which, *M. Fusseleni*, occurs in the south of Europe, and another, *M. Cichorii* (fig. 137, 2), in Syria, and apparently throughout the East. In India it is called *telee* and *telee mukhee*, or the oil fly,—no doubt from the oil-like exudation which the insects of this genus give out from the articulations of their legs when seized. Another species, *M. Trianthemæ*, is mentioned by Dr Fleming; and the *Lytta gigas*, Fab., is found there as well as in Senegal. One is mentioned by the Arabs under the name of *zurareh*. It is not known when the prescribed blistering fly came to be used; but it has had a variety of names. It was called *Meloe vesicatorius* by Linnæus, *Lytta vesicatoria* by Fabricius, and *Cantharis vesicatoria* by Geoffrey, a name adopted by the Pharmacopœias. Geoffrey grouped the Vesicatory beetles in a small tribe corresponding nearly with the Linnæan genus Meloe, and distinguished it by the title Cantharideæ. This he divided into eleven genera, among which are the *Cantharis*, *Mylabris*, and *Meloe*, species of all of which have been employed as vesicatories. *Meloe majalis*, or Mayworm, is figured at fig. 137, 1, as a specimen of the genus.

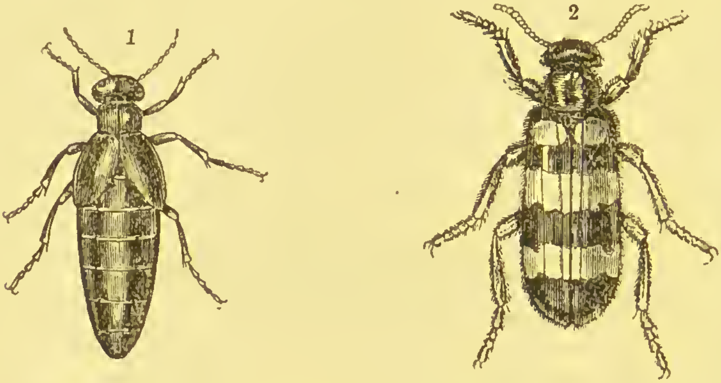

Fig. 137.—1. *Meloe majalis*; 2. *M. Cichorii.*

Cantharis, *P.B.* *Cantharides* (*Spanish Flies*).

Cantharis vesicatoria, De Geer, *Hist des Insectes*, the Beetle dried. Collected chiefly in Hungary.

Characters.—Body elongated, almost cylindrical, from 6 to 10 lines long by about 2 broad, the male somewhat smaller than the female. It is easily distinguished by its two beautiful *elytra* or wing cases, which are long and flexible, and of a shining golden-green colour, and cover two thin brownish membranous wings. *Head* large and subcordate, with a longitudinal furrow extending to the thorax: this is not larger than the head, rather quadrate. The thorax chiefly, but also the rest of the body, is covered with whitish-grey hairs; *antennæ* black, long, simple, filiform. The *maxillæ* support the jointed *palpæ*, of which the terminal joint is somewhat ovate. The *legs* are from 4 to 6 lines long, smooth, 5 joints to the first pair of the *tarsi*, and 4 only to the last, all violaceous. A single spine on the leg and notch in tarsus. The last joint of tarsus with a pair of claws, each of which is bifid.

Near the anus of the female are two articulated *caudal appendages,* somewhat similar to palpi. *Hab.*—It abounds in the south of France, Spain, and Italy; and it has spread into Germany and the south of Russia. It is found upon the ash, lilac, and privet especially, but also upon the elder and honeysuckle, and more rarely on the plum tree, rose, willow, and elm. M. Farines states that the insects produced in warm places, and such as are exposed to the sun, are the most energetic as vesicants.

Cantharides are said to live only eight or ten days. When alive they exhale a strong, fœtid, and penetrating odour, by which their presence is readily detected, and which is so offensive that public walks sometimes become deserted until they have disappeared. They are usually caught early in the morning, when persons with covered hands and faces shake them off the trees, plunge them into vinegar, or expose them in sieves to the vapour of vinegar, and then dry them in the sun or in warmed apartments. They should be preserved in well-stoppered bottles containing a lump of camphor, as they are subject to the ravages of *Acarus domesticus, Tinea flavifrontella, Anthrenus muscorum,* and *Hoplia farinosa.* They long preserve their form and colour, and also to some extent the disagreeable odour of the living insect, and have an acrid burning taste. The powder is greyish-brown, interspersed with shining particles, which are the fragments of the elytra, head, and feet; though comparatively inert, these parts are very indestructible, and we are often enabled to detect their presence in cases of poisoning.

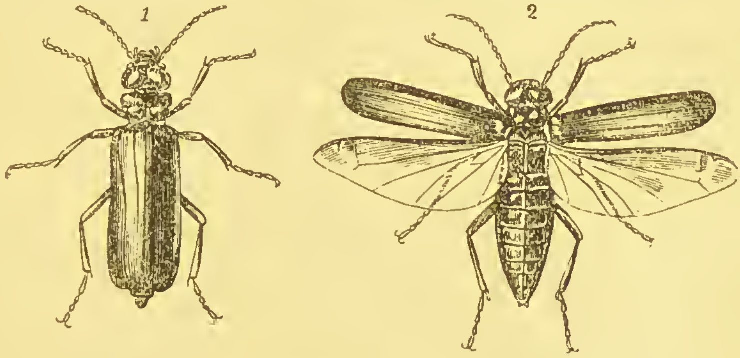

Fig. 138.—*Cantharis vesicatoria.*

Cantharides contain a *green oil,* a *fatty matter, osmazome,* free *acetic* and *uric acids, phosphates of lime* and *magnesia,* and the active principle, *cantharidin,* $C_5H_6O_2$. This is intermediate in nature between volatile oils and resins. It crystallises in white shining plates, fuses into a yellow oil at about 405°, and is volatilised at a higher temperature, and condenses unchanged in acicular crystals. It is soluble in æther, and in strong acids and alkalies. When isolated, it is insoluble in water and cold spirit; but these menstrua are enabled to dissolve it out of cantharides by the aid of some other principles in the flies. Robiquet found that $\frac{1}{100}$th of a grain produced painful blistering of the surface. It volatilises slowly even at low temperatures, and the vapour powerfully irritates the eyes.

Action. Uses.—A *violent irritant*, acting externally as a rubefacient and vesicant. If 20 or 30 grains of the powder be taken into the stomach it produces immediate emesis, and the patient soon becomes exhausted by repeated vomiting and severe epigastric pain, then follow involuntary discharges of fæces, dysuria, with bloody urine, severe dysenteric purging, with bloody stools; and in women menorrhagia. The pain continues very severe, and the patient ultimately falls into a state of collapse, and dies in about forty-eight hours from the time of ingestion of the poison. Severe catarrhal inflammation of the gastro-intestinal mucous membrane with hæmorrhagic patches, and severe congestion, with ecchymosis of the kidneys, bladder, uterus, and ovaries, are the prominent post-mortem indications of its irritant action. In small doses it is a stimulant diuretic and emmenagogue; useful in inducing a healthy state of the mucous membrane in chronic gonorrhœa and leucorrhœa. In full medicinal doses cantharides acts as a powerful stimulant to the sexual organs. In debility of these organs and in paralysis of the bladder, cantharides, in combination with iron, has sometimes been used with advantage. It is chiefly employed as a *vesicant*, the blister appearing after from six to twelve hours' contact with the skin. Strangury and boils—the one an immediate and the other a remote effect—are the consequences of too prolonged a contact of the blister. Ulceration, or even sloughing, may follow in delicate children from the same cause. It is also employed as a *rubefacient* in alopecia.

Treatment of Poisoning by Cantharides.—The free use of chalk and opium, and olive oil, both by the mouth and the rectum.

1. **Tinctura Cantharidis**, *P.B.* *Tincture of Cantharides.*

Prepared by macerating ¼ ounce of *cantharides* in coarse powder in 1 pint of *proof spirit* for seven days, with occasional agitation, straining, pressing, filtering, and adding sufficient proof spirit to make 1 pint.

Action and Use.—A stimulant diuretic in amenorrhœa, leucorrhœa, incontinence of urine from atony of the bladder, and in gleet. Mixed with 4 parts of rose-water, it may be used as a stimulating hair wash.

Dose.—5 to 20 minims, cautiously increased.

2. **Acetum Cantharidis**, *P.B.* *Vinegar of Cantharides.*

Preparation.—Mix 13 fluid ounces of *acetic acid* with 2 fluid ounces of *glacial acetic acid*, and digest 2 ounces of *cantharides* in powder, in this mixture for two hours at a temperature of 200°; then transfer the ingredients after they have cooled to a percolator, and when the liquid ceases to pass pour 5 fluid ounces of *acetic acid* over the residuum in the apparatus. As soon as the percolation is complete, subject the contents of the percolator to pressure, filter the product, mix the liquids, and add sufficient acetic acid to make 1 pint.

Action and Uses.—This is a powerful rubefacient and mild vesicant, adapted for many cases where a rubefacient action is immediately required, and for delicate children, for whom the stronger preparations are unsuitable. As a vesicant it may be used alone, painted several times on the skin with a camel's hair brush; or as a rubefacient mixed with an equal part of soap liniment, and used with friction in indolent rheumatic affections of the joints.

3. **Liquor Epispasticus,** *P.B. Blistering Liquid.*

Preparation.—Mix 8 ounces of *cantharides* in coarse powder with 4 fluid ounces of *acetic acid;* pack them in a percolator, and at the expiration of twenty-four hours pour *æther* over the contents, and allow it to pass slowly through till 1 pint of the liquor is obtained. Keep it in a stoppered bottle.

Action and Uses.—This is an efficient vesicant where a rapid effect is required, and when, from a restless state or resistance of the patient, a blister cannot be retained. It should be painted on with a brush, once, twice, or more, according to the effect desired. As a counter-irritant it is a valuable preparation; but as it does not elicit much serum, it is far inferior to Emplastrum cantharidis in its power of relieving internal congestion.

4. **Charta Epispastica,** *P.B. Blistering Paper.*

Preparation.—Digest 4 ounces of *white wax,* 1½ ounce of *spermaceti,* 2 ounces of *olive oil,* ¾ ounce of *resin,* and 1 ounce of *cantharides* in powder in a water bath for two hours, stirring them constantly; then strain, and separate the plaster from the watery liquid, (?) Mix ¼ ounce of *Canada balsam* with the plaster melted in a shallow vessel, and pass strips of paper over the surface of the hot liquid, so that one surface of the paper shall receive a thin coating of plaster.

It may be convenient to employ paper ruled so as to indicate divisions, each of which is one square inch.

Action and Uses.—A mild vesicant, very convenient and cleanly. If retained in contact with the skin for an hour or two it produces redness without vesication.

5. **Emplastrum Cantharidis,** *P.B. Blistering Plaster.*

Preparation.—Liquefy 7½ ounces each of *yellow wax* and *prepared suet,* and 6 ounces of *prepared lard* together by a water bath, and add 3 ounces of *resin* previously melted; then introduce 12 ounces of *cantharides* in powder; mix the whole thoroughly, and continue to stir the mixture while it cools.

Action and Uses.—A powerful vesicant, contact for seven to twelve hours generally resulting in the formation of one or more large bags of serum. When the skin is hot and perspiring the action is more rapid; if it be harsh and cold the action is much hindered, and should be encouraged by a large hot linseed poultice placed over the blister, or by the previous application of Cataplasma sinapis. If the contact be prolonged after vesication is induced, cantharidin is absorbed and is liable to produce strangury, and, subsequently, a crop of troublesome boils in the neighbourhood of the blister. When it can be done without disturbing the patient, the edge of the blister should be gently raised at the end of five or six hours, to observe the effect.

6. **Unguentum Cantharidis,** *P.B. Cantharides Ointment.*

Preparation.—Infuse 1 ounce of *cantharides* in 6 fluid ounces of *olive oil* in a covered vessel for twelve hours, then place the vessel in boiling water for fifteen minutes, strain through muslin with strong pressure, add the product to 1 ounce of *yellow wax* previously melted, and stir constantly while the mixture cools.

Action and Uses.—This is used as an irritant to promote discharge from ulcers, and keep open blisters and issues. Care must be used in applying it to an extensive surface, or strangury may result from the absorption of cantharidin.

7. **Emplastrum Calefaciens,** *P.B. Warm Plaster.*

Preparation.—Infuse 4 ounces of *cantharides* in coarse powder in 1 pint of *boiling water* for six hours; squeeze strongly through calico, and evaporate the expressed liquid by a water bath till reduced to one-third. Then add 4 ounces each of *expressed oil of nutmeg*, *yellow wax*, and *resin*, 3¼ pounds of *soap plaster*, and 2 pounds of *resin plaster*, and melt in a water bath, stirring well until the whole is thoroughly mixed.

Action and Use.—A stimulant application in lumbago and chronic affections of the joints, and in chronic rheumatism. It may be worn on the chest as a rubefacient in chronic catarrh and bronchitis.

COCCUS CACTI, *Linn.* The Cochineal Insect.

This hemipterous insect is the source of carmine. It is a native of Mexico and Central America. It is extensively cultivated in Mexico and Teneriffe.

Characters.—Male—Body oblong-elliptical, deep red, terminating posteriorly in two long divergent *setæ*. *Wings* 2, white, crossed above the abdomen. *Antennæ* of 11 joints, about two-thirds the length of the body. *Rostrum* absent. *Tarsi* of 1 joint and a single terminal hook. *Female* nearly twice as large as the male. *Body* broadly elliptical, bluish-red, covered with a white powder. *Apterous* furnished with a rostrum, antennæ short.

Cochineal insects are reared on the *Opuntia cochinilifera*, a cactaceous plant, with flattened elliptical branches. The impregnated females are placed on this plant, and they there deposit their young. After a few months, when the females are fecundated, they are brushed off, killed by immersion in hot water, and then dried. Three harvests are annually gathered, the female alone being collected.

1. **Coccus,** *P.B. Cochineal.*

The dried female insect, reared in Mexico and Teneriffe.

Characters and Constituents.—Ovate, plano-convex, about 2 lines long, wrinkled, black or greyish-white; yields when crushed a pucecoloured powder. The greyish-white insect quickly becomes black when warmed before the fire. They are chiefly composed of fatty and colouring matter. The latter is called *carmine, cochinellin,* or *carminic acid,* $C_{14}H_{14}O_8$. It may be obtained by digesting the dried insect, deprived of fat by previous maceration in æther, in alcohol, which dissolves the carmine. After distillation of the alcohol it remains as an amorphous powder of a brilliant rose-red colour. De la Rue obtained it from an aqueous infusion of the powdered insects, from which fat had been removed. On the addition of plumbic acetate lead-lake is precipitated. This is washed, decomposed by sulphuretted hydrogen, and the filtered solution evaporated in vacuo over sulphuric acid. Carmine is soluble in all proportions in alcohol, in water, and in the caustic alkalies, forming reddish-purple solutions; very sparingly soluble in æther. It dissolves unchanged in sulphuric and hydrochloric acids, but is readily decomposed by nitric acid, even when dilute, and by chlorine, iodine, and bromine, all of which change the colour to yellow. Nitric acid converts it into nitrococcusic acid, $H_2C_8H_3(NO_2)_3O_3,H_2O$, which crystallises in rhombic plates, and forms soluble salts. Carmine forms with salts of tin a bright crimson solution, which is used for dyeing.

Varieties.—These are—1. **Silver**, recognised by the presence of a soft silvery white powder, contained in the furrows and wrinkles. It appears to be a fatty substance, as it melts on the application of heat, and the animals lose their silvery appearance. This variety is said to be the mature and fecundated insect. 2. **Black** cochineal, of a reddish-black colour, nearly devoid of silvery powder. It is supposed to be the female exhausted by propagation. 3. **Granilla**, an inferior kind, composed of small and imperfect insects.

Action and Uses.—It is reputed to be anodyne and antispasmodic, but of this there is no proof whatever. It is merely used for colouring, and is employed for this purpose in Tinctura cardamomi composita, Tinctura cinchonæ composita, and the following:—

2. Tinctura Cocci, *P.B.* *Tincture of Cochineal.*

Prepared by macerating 2½ ounces of *cochineal* in powder in a pint of *proof spirit* for seven days, with occasional agitation; straining, pressing, filtering, and adding sufficient proof spirit to make 1 pint.

Use.—To colour mixtures and lotions red. The fixed alkalies turn it purple. Lime water precipitates the colouring matter.

3. Syrupus Cocci. *Syrup of Cochineal.*

This may be prepared by boiling 80 grains of bruised *cochineal* in 1 pint of *water* for fifteen minutes, constantly stirring, and then adding sufficient *sugar* and *rectified spirit* (see Syrupus violæ) to form a syrup.

Use.—It may be used instead of the previous article if alcohol be incompatible with any of the constituents of the mixture to which it is added.

MEL, *P.B.* Honey.

A saccharine secretion deposited in the honeycomb, by *Apis mellifica*, Linn., the hive bee.

Honey is secreted by the nectaries of flowers, and sucked by the bee into its crop, where it undergoes some slight changes, and is then stored up in the comb. The finest honey is that which is allowed to drain from thence; and, if obtained from hives which have never swarmed, it is called virgin honey. It partakes of the aroma of the plants from which the bees collect it.

Characters and Composition.—When recently separated from the honey-comb, it is a viscid translucent liquid, of a brownish-yellow colour, but gradually becomes partially crystalline and opaque. It has a heavy aromatic odour, and a very sweet taste. Honey is chiefly composed of *sugar* and *water;* it contains besides a little *volatile oil* derived from the flowers on which the bees have fed, *gum*, and *wax*. The sugar is partly crystalline, *sucrose* and *glucose* (see p. 322), partly uncrystallisable, *lævulose* (see p. 320.) Lævulose forms the uncrystallisable syrup of old honey; it is so called because it rotates a ray of polarised light to the left. It reduces an alkaline solution of cupric tartrate, and forms a crystalline compound with lime, $2C_6H_{12}O_6,3CaO$. It absorbs hydrogen from an amalgam of sodium, and is converted into mannite (see p. 524). Heated to 338° lævulose loses water and is converted into lævulosane, $C_6H_{10}O_5$, an amorphous, unfermentable substance, soluble in water, and reconverted by boiling with water, especially if it contain a little acid, into lævulose.

Honey is soluble in water. The solution undergoes alcoholic fermentation, and is converted into a vinous fluid termed *hydromel* or *mead.*

Test.—Boiled with water for five minutes and allowed to cool the mixture does not become blue with solution of iodine; this proves the absence of starch, a very common adulteration. Cane sugar, another adulteration, is not so easily detected.

1. Mel depuratum, *P.B.* *Clarified Honey.*

This is prepared by melting honey in a water bath, and straining while hot through flannel previously moistened with warm water.

Action and Uses.—Antiseptic, demulcent, nutritive, and slightly laxative. It is used as an application to cracks of the skin, chaps, and to sore mouth, and as a gargle with vinegar and water.

Pharmaceutical Uses.—A constituent of Confectio piperis, C. scammonii, C. terebinthinæ, Mel boracis, Oxymel scillæ, and the following:—

2. Oxymel, *P.B.* *Oxymel.*

Preparation.—Liquefy 40 ounces of *clarified honey* by heat, and mix with it 5 fluid ounces each of *acetic acid* and *water.*

Action and Uses.—Demulcent and refrigerant. It may be given as a linctus in cough. As a refrigerant (½ ounce to ½ pint of barley water) in fever, or used as a gargle (1 ounce to 5 ounces of water).

Dose.—1 to 2 fluid drachms.

CERA APIS, Bees-Wax.

This substance is secreted by glands on the ventral scales of the bee, whence they collect it and build the cells of the comb with it. Its yellow colour is lost by exposure to the air; it may also be bleached by means of nitric acid. Chlorine cannot be used for this purpose, because it displaces a portion of the hydrogen of the wax. It is composed of *myricin*, *cerin* or *cerotic acid*, and *cerolein*. These bodies may be separated by boiling alcohol, which dissolves all but the myricin, and on cooling deposits the cerin.

Myricin is *melissyl palmitate*, $C_{30}H_{61},C_{16}H_{31}O_2$. It is the chief constituent of wax, forming more than two-thirds of its weight; melts at 147°·2; is insoluble in alcohol, but soluble in benzol and in æther. It is saponified when boiled with the alkalies, forming a palmitate of the base, and melissin or melissyl alcohol $C_{30}H_{62}O$ is liberated. Melissin separates from benzol in satiny crystals. When fused with caustic potash it is converted into melissic acid $H,C_{30}H_{59}O_2$, which is homologous with acetic acid.

Cerin, $H,C_{27}H_{53}O_2$, forms about 22 per cent. of wax (Brodie). It fuses at 174°·2 in 16 parts of boiling alcohol, and separates in a crystalline form on cooling; it is soluble in æther, and yields, by saponification, palmitic, stearic, and a minute quantity of oleic acids, but it is chiefly composed of a non-saponifiable fat.

Cerolein forms about 5 per cent. of wax, and gives to it the appropriate colour and odour. It is a soft fat of acid reaction, soluble in cold alcohol.

1. **Cera flava**, *P.B.* *Yellow Wax.*

The prepared honeycomb of the hive bee, *Apis mellifica*, Linn.

Characters.—Firm, breaking with a granular fracture, yellowish, having an agreeable honey-like odour. Not unctuous to the touch; does not melt under 140° (both of which characters proves the absence of lard and suet); yields nothing to cold alcohol (absence of resin); entirely soluble in oil of turpentine (absence of pea flour). Boiling water in which it has been agitated, when cooled, is not rendered blue by iodine (absence of starch).

Pharmaceutical Uses.—A constituent of Emplastrum calefaciens, E. cantharidis, E. cerati saponis, E. galbani, E. picis, and the following ointments:—U. cantharidis, U. hydrargyri compositum, U. hydrargyri oxydi rubri, U. picis liquidæ, U. resinæ, U. sabinæ, U. terebinthinæ.

2. **Cera alba**, *P.B.* *White Wax.*

Yellow wax bleached by exposure to moisture, air, and light. This is effected by causing it to fall in a melted state, in small streams, upon a revolving wetted cylinder; it concretes in thin ribbon-like layers, which being exposed for some time to the united influence of light, air, and moisture, become bleached, and of a yellowish-white colour.

Characters.—Hard, nearly white, translucent. Not unctuous to the touch; does not melt under 150°.

Adulterations.—Pure bleached wax always retains a faint yellowish tinge. Spermaceti is sometimes added to remove this, and it is also adulterated with suet (see below). The melting point will aid in the detection of these impurities.

Action and Uses.—Emollient and demulcent. It has been employed as such internally as an emulsion made by beating together melted wax with yolk of egg and a hot solution of mucilage.

Pharmaceutical Uses.—A constituent of Charta epispastica, Suppositoria acidi tannici, S. hydrargyri, S. morphiæ, S. plumbi composita, and of Unguentum cetacei, U. plumbi subacetatis compositum, U. simplicis.

3. **Unguentum simplex**, *P.B.* *Simple Ointment.*

Prepared by melting together 2 ounces of *white wax* and 3 ounces each of *prepared lard* and *almond oil*, in a water bath, and stirring the mixture constantly while it cools.

Action and Uses.—A soothing application to excoriated surfaces and wounds, and employed as the basis of the following more active ointments:—U. antimonii tartarati, U. cadmii iodidi, U. kreasoti, U. elemi, U. hydrargyri ammoniati, U. iodidi rubri, U. plumbi carbonatis, U. plumbi iodidi.

SEVUM PRÆPARATUM, *P.B.* Prepared Suet.

The internal fat of the abdomen of the sheep, *Ovis aries*, Linn., purified by melting and straining.

Characters and Constituents.—White, smooth, almost odourless; fusible at 103°. It is almost wholly composed of *stearin*, the remainder being *palmitin* and *olein*. (For the composition of these glycerides, see p. 242.)

Action and Uses.—It is employed externally for the same purposes as wax. Internally it is nutritious like other fats, but on account of its hardness and higher melting point, it is not so readily digested. The process is greatly facilitated by chopping it very fine and mixing it with flour. This compound is a most sustaining article of diet.

It is a constituent of Emplastrum cantharidis and Unguentum hydrargyri.

CETACEUM, *P.B.* Spermaceti.

Nearly pure *cetin* $C_{32}H_{64}O_2$ obtained, mixed with oil, from the head of the sperm whale, *Physeter macrocephalus*, Linn., inhabiting the Pacific and Indian Oceans. It is separated from the oil by filtration and pressure, and afterwards purified.

Characters and Tests.—A solid crystalline fat, sp. gr. ·940, pearly-white, glistening, with little taste or odour, reducible to powder by the addition of a little rectified spirit. Scarcely unctuous to the touch; melts at about 120°; insoluble in cold, but freely in hot alcohol and in hot æther. Spermaceti is peculiar in yielding *ethal* $C_{16}H_{34}O$, in place of glycerin, when saponified. Ethal is a white crystalline solid; it has the same relation to palmitic acid as alcohol has to acetic acid, and when heated with caustic potash, it is converted into palmitic acid, $HC_{16}H_{31}O_2$, which displaces the hydrogen of the base forming palmitate, just as occurs when the vapour of alcohol is pressed over caustic potash. With sulphuric acid ethal forms a conjugate acid, $HC_{16}H_{33}SO_4$, exactly corresponding to sulphethylic acid (see p. 330).

Spermaceti is distinguished from the crystalline constituents of wax by its lower fusing point.

Action and Uses.—Those of wax. It may be given internally in the form of emulsion (see Cera alba). It is a constituent of Charta epispastica and of the following ointment:—

1. **Unguentum Cetacei,** *P.B.* *Spermaceti Ointment.*

Prepared by melting together 5 ounces of *spermaceti*, 2 ounces of *white wax*, and 1 pint of *almond oil*, then removing from the water bath, and stirring constantly while it cools.

This is a simple emollient ointment, employed to prevent or to soothe irritation.

ADEPS PRÆPARATUS, *P.B.* Prepared Lard.

The purified fat of the hog, *Sus scrofa*, Linn.

Preparation.—Remove as much of the membranes as possible from the *internal fat of the abdomen* of the hog perfectly fresh. Cut the fat into small pieces, put it into a suitable vessel with about four gallons of *cold water*, and, while a current of water is running through the vessel, break up the masses of the fat with the hands, exposing every part to the water, so that whatever is soluble may be thus dissolved and carried away. Afterwards collect the washed fat on a sieve or in a cloth, drain away the water, liquefy the fat at a heat not exceeding 212°, and strain through flannel, pressing the residue while hot; then put it into a pan heated by steam, and keep it at a temperature a little, but not much, above 212°, stirring it constantly until it becomes clear and entirely free from water. Finally, strain it through flannel.

Characters, Constituents, and Tests.—A soft solid fat of snowy whiteness, melting at about 100°, free from rancid odour, dissolves entirely in æther. It is composed of 62 per cent. of olein and 38 of palmitin and stearin (see p. 242). Distilled water in which it has been boiled, when cooled and filtered, gives no precipitate with nitrate of silver (absence of chloride of sodium), and is not rendered blue by solution of iodine (absence of starch).

Adulterations.—More than 20 per cent. of farinaceous matter has been found in lard (Whipple); and Crace Calvert found that

American lard (adulterated in England) contained, in addition to starch, 10 per cent. of water, 2·3 of alum, and 1 of lime. These impurities are mixed in by machinery, and are used to make it whiter.

Action and Uses.—Lard is a valuable emollient, and is especially useful in lubricating the vagina and rectum preparatory to the birth of the child or the expulsion of impacted fæces. It is a constituent of nearly one-half of the ointments, of Emplastrum cantharidis, and of the following:—

1. **Adeps benzoatus**, *P.B. Benzoated Lard.*

Preparation.—Melt 1 pound of *prepared lard* by the heat of a water bath, add 160 grains of *benzoin* reduced to coarse powder, and frequently stirring them together, continue the heat for two hours; finally, remove the residual benzoin by straining.

The benzoin is added to prevent the development of rancidity and to confer a pleasant odour. It very imperfectly fulfils the first object, and salicylic acid may be advantageously substituted in its stead or as an addition.

Pharmaceutical Uses.—A constituent of the four suppositories which contain wax, and of the following ointments: U. gallæ, U. plumbi acetatis, U. sulphuris, and U. zinci.

OLEUM MORRHUÆ, *P.B.* Cod-Liver Oil.

The oil extracted from the fresh liver of the cod, *Gadus Morrhua*, Linn., by the application of a heat not exceeding 180°.

The oil obtained from the liver of the common cod (the *Assellus* of Pliny and of some modern naturalists) has long been in use as a popular remedy in Sweden and other parts of Northern Europe. In 1782 it was strongly recommended in England by Dr Percival as a remedy for chronic rheumatism; but it is only recently that it has been so extensively employed in scrofulous and consumptive cases as to necessitate its formal introduction into the Pharmacopœias. The livers of several other species of *Gadus*, as the *G. callarius*, *G. earbonarius*, and *G. molva*, yield a considerable part of the cod-liver oil of commerce. This mostly comes from the coast of Newfoundland, where cod-fish are so abundant.

There are several modes of extracting the oil. The best and finest oil is obtained by a process in which the livers are neither exposed for such a time as to allow them to putrefy, nor subjected to a heat sufficient to decompose the oil or animal matter. The best livers, selected and cleaned, are sliced and exposed to a heat of about 180° until all the oil has drained from them. This is filtered and cooled to a temperature below 50° to congeal the solid fat, then again filtered and kept in closed jars.

Inferior kinds of oil are prepared on the coast of Newfoundland and Norway by rougher processes. Sometimes a number of tubs are bored with holes at the bottom, and a layer of fir-twigs placed above them. The livers are then piled in the tubs upon the twigs, and allowed to remain there for a considerable time, exposed to the sun and air. The substance of the livers gradually putrefies, allowing the oil to run out through the twigs into vessels placed below to receive it. Oil obtained in this way, unless afterwards purified, is apt to be brown, rancid, and nauseous.

Another mode of extraction consists in boiling the livers in an iron pot, and separating the oil by filtration and expression through a cloth. This plan is said to be adopted by the fishermen at Newhaven in Scotland. If water be not added, or the operation performed carelessly, the product may contain empyreumatic matters produced by the heat employed.

Characters, Constituents, and Tests.—Pale yellow, with a slight fishy odour, bland fishy taste, and feebly acid reaction; sp. gr. ·928. It is composed of about 80 per cent. of *olein*, 15 of *palmitin*, and of small portions of *acetin* (a compound of acetic acid with glycerin), *cholic acid*, *butyric acid*, 0·37 per cent. of *iodine*, 0·148 of *bromine* and *chlorine*, ·021 of *phosphorus*, with *phosphoric* and *sulphuric acids*, *lime*, *magnesia*, and *soda* (De Jongh).

According to Winkler, cod-liver oil does not contain any true glycerin, but, instead of it, an analogous substance called *propyl* $(C_3H_7)_2$. If the oil be heated in a retort, with potash, lime, and ammonic chloride, a volatile liquid, *propylamine*, (C_3H_7, H_2N), isomeric with trimethylamine (see p. 337), quite colourless, and with a strong herring-like odour, may be distilled over (Buchner's *Repertorium*, 1852).

A drop of sulphuric acid, added to a few drops of the oil on a porcelain slab, develops a violet colour, which soon passes to a yellowish or brownish-red. This test is an indication of a liver oil, the reaction being due to the cholic acid, a constituent of bile.

Varieties.—De Jongh describes three kinds of oil as found on the Continent. They also occur in English commerce. They differ in colour, being *pale yellow*, *pale brown*, and *dark brown*. All have a peculiar odour, a subacrid fishy taste, a feeble acid reaction, and sp. gr. about ·924. Cold alcohol dissolves from 2 to 3 per cent., hot alcohol from 3 to 7 per cent.; the oil is soluble in æther in all proportions. The *dark brown* oil is more impure than the other kinds; the odour and taste are disagreeable and empyreumatic; and the sp. gr. may be as high as ·929. De Jongh has analysed these three kinds with great care, but he does not find them to differ materially in composition. The dark colour is due to two causes, viz., the use of livers which are not fresh, and exposure to a higher temperature than is required for the mere separation of the oil. The pale kind is that which is prescribed in the Pharmacopœia.

Substitutes.—The livers of some other fishes, nearly related to the cod, as the *dorse*, *burbot*, and *ling*, are supposed to yield a small part of the cod oil of commerce. This mostly comes from the coast of Newfoundland, where cod-fish are so abundant.

Shark-liver oil has been lately imported into Liverpool. It agrees with the cod-liver oil in many of its chemical reactions, but is distinguished from it by its low specific gravity, which is ·866. It is probably the lightest fixed oil known. Sperm oil is perhaps the next lightest; its sp. gr. is ·875. The shark-liver oil is obtained by the skippers from sharks caught on the coast of Africa. Some also come from Malabar.

There is no means of distinguishing between these liver oils and that of the cod.

Action and Uses.—Cod-liver oil is a very digestible fat, and in all diseases or conditions in which there is deficiency of adipose tissue or of animal heat, the digestive organs being healthy, it is a very excellent article of diet. Owing to the presence of a little iodine it has been supposed to exert an alterative action in scrofulous affections, in pulmonary phthisis, and in other diseases, but its beneficial effects may be wholly ascribed to its easy digestion and rapid assimilation. It should be given as a supplement to the ordinary meal. It is especially useful during convalescence from acute disease, such as a prolonged attack of enteric fever, scarlatina, or pneumonia. Fat is an essential constituent of the red corpuscle, and under the use of cod-liver oil Dr Theophilus Thompson has noted an increase of these constituents of the blood in pulmonary phthisis. In all cases of anæmia, and especially that which is associated with disease of the mesenteric glands, cod-liver oil has been found extremely beneficial.

Dose.—1 to 8 drachms, floated on a little orange wine, milk, or peppermint water. Small doses should be persevered in, for patients soon become accustomed to the oil, and often relish it. Larger doses than 3 fluid drachms twice a day are rarely needed. It may be given in combination with the iodides of iron and mercury.

GELATIN, or Gelatine.

Isinglass, gelatin, glue and size, are the various forms under which this substance occurs. It is obtained from the collagenous tissues (bones, horns, hoofs, and hides) of animals by steam. In chemical composition it differs but little from albumin, containing a smaller quantity of sulphur and carbon, and a larger proportion of nitrogen, than this substance. 100 parts contain 50·40 of *carbon*, 6·64 of *hydrogen*, 18·34 of *nitrogen*, 0·5 of *sulphur*, and 24·46 of *oxygen*. The ordinary form of gelatin is that of amber-coloured, transparent, or semi-transparent clippings of horn-like layers, tasteless and odourless. It softens and swells up in cold water, and dissolves, forming a colourless or faint straw-coloured solution in hot water; and if the solution contain 1 per cent. of gelatin it forms a jelly on cooling. It is insoluble in alcohol and in æther, which indeed precipitate it from an aqueous solution in the form of white flocculi. The aqueous solution is also precipitated by solution of corrosive sublimate and infusion of galls, the deposit formed by the latter being leather.

By prolonged boiling with dilute sulphuric acid gelatin is resolved into glycocin, leucin, and a little saccharine matter susceptible of the alcoholic fermentation. Prolonged exposure of the solution, or boiling with alkalies, deprive gelatin of its property of gelatinising. In the latter process it is converted into glycocin, leucin, and some other products.

1. **Ichthyocolla,** *P.B.* *Isinglass.*

The swimming-bladder or sound of various species of sturgeon, *Acipenser*, Linn., prepared and cut into fine shreds.

The name is derived from ἰχθὺς, a fish, and κόλλα, glue, and is translated isinglass, a word derived from the German *hausinblase*, from *hausen*, the great sturgeon, and *blase*, a bladder, being one of the coats of the swimming-bladder of fishes, chiefly of the genus Acipenser or sturgeon, and of which the best qualities are imported from the rivers of Russia, flowing from the Black and Caspian Seas as well as from the Sea of Aral and the Lake of Baikal. Isinglass is also imported from Brazil, from India, and from North America. Of late the quality of American isinglass has been much improved. Isinglass is the purest known form of gelatin. It exists in various forms, as *purse*, *lump*, *pipe*, *leaf*, *ribbon*, and *book* isinglass.

The finest Russian isinglass consists of about 98 per cent. of gelatin, the remainder being albumin in combination with earthy salts.

15 grains of isinglass dissolved in 1 ounce of boiling water forms a firm jelly on cooling.

Action and Uses.—Gelatin occurs as an article of diet in the form of cooked membranes and tendons, especially in veal, the chief constituent of the head and feet of the calf being gelatin. It is also taken in the form of jellies and blancmange. It has been hastily assumed that the nutritive properties of gelatin are very low, but this is scarcely borne out by experience. It is a very suitable diet, especially in combination with milk, for invalids who are unable to take a more solid food. Half an ounce of isinglass, or 1 ounce of gelatin, dissolved in 16 ounces of boiling water, with the addition of 4 ounces of lemon or orange juice, and 2 ounces or sufficient of sugar, forms, when strained and cooled, an agreeable jelly. A strong solution of isinglass painted over thin silk forms the useful adhesive plaster known as "Court sticking plaster." A dried solution of gelatin, lemon juice, and sugar is formed into "gelatine lozenges," which are very useful in relieving dryness and huskiness of the throat in catarrh. Isinglass and gelatin are usefully employed to clear turbid fluids, such as wines. They act as mechanical strainers, the strainer being formed of an insoluble compound of gelatin, and some constituent of the liquid, which as it slowly sinks to the bottom of the fluid carries with it the suspended particles which cause the turbidity.

Isinglass is used as test in the following solution:—

2. **Solution of Gelatin,** *P.B.*

Preparation.—Digest 50 grains of *isinglass* in shreds in 5 ounces of warm *water* for half an hour on a water bath, with repeated shaking, and filter through clear tow moistened with water.

Use.—To distinguish gallic from tannic acid. It gives no precipitate with the former.

OVUM. The Egg of the Domestic Hen.

The common fowl (*Gallus Banckiva*, var. *domesticus*, Temminck), domesticated everywhere, is probably derived from the Jungle Fowl of India. Its egg is well known as a highly esteemed article of diet. The shell, consisting almost entirely of *carbonate of lime*, is seldom now employed. Within the shell there is a white semi-opaque albuminous membrane, which contains the white of egg, or *albumin ovi*, a glairy, viscid fluid, contained in very delicate membranous cells. The liquid is mainly a strong solution of *albumin*, $C_{72}H_{110}N_{18}SO_{22}H_{20}$, as it consists of 12 per cent. of this principle, with 85 of water, 2·7 of *mucus*, and 0·3 of saline substances, including *soda* and traces of *sulphur*. The glairy liquid is miscible with water, and is coagulated by heat under 212°, becoming white, opaque, and insoluble. It is precipitated by corrosive sublimate, subacetate of lead, nitrate of silver, and other metallic salts forming definite compounds, that of mercury has the composition $HgC_{72}H_{110}N_{18}SO_{22},H_2O$. The copper compound is soluble in excess of solution of cupric sulphate or of potash, forming in the latter case a characteristic violet-coloured liquid. Albumin forms soluble compounds with the acids; that with nitric acid has the formula $C_{72}H_{110}N_{18}SO_{22},2HNO_3$ (W. S. Johnson, *Journal Chem. Soc.* vol. xii. p. 734).

A solution of albumin is distinguished from one of casein by means of acetic acid which precipitates the latter. From gelatin, albumin is readily distinguished by boiling, or by a solution of potassium ferrocyanide containing acetic acid, which precipitates the albumin.

Egg-albumin differs from that of blood-serum in being coagulated by æther.

1. Solution of Albumin, *P.B.*

Prepared by triturating the white of 1 *egg* in 4 ounces of *water*, and straining through clean tow first moistened with distilled water.

It is a glairy solution of alkaline reaction, coagulating by heat, and by excess of nitric acid, which imbues it with a deep citron colour.

Use.—An antidote in poisoning by corrosive sublimate and sulphate of copper. Large quantities of the fluid should be taken, and vomiting subsequently encouraged. It may be used as a demulcent in poisoning by any irritant, but especially the metallic salts. White of egg may be used to clarify liquids instead of gelatin. It acts in the same way (see p.799).

2. Ovi vitellus, *P.B.* *Yolk of Egg.*

The yolk of egg is contained within a delicate sac, the *vitelline membrane*, which separates it from the white or glaire.

Composition.—According to Prout the yolk is composed of 28·75 per cent. of *yellow oil* with *crystallisable fat*, 17·47 of *albumin* associated with *phosphorus*, and 58·8 of *water*.

Action and Uses.—Both white and yolk of egg are highly nutritious, the latter, however, is more so, not only on account of the larger quantity of albumin, but also because it is intimately associated with oil, and in such proportions as facilitate the absorption of both constituents. It is very usefully employed in forming emulsions of oils, fats, and resinous bodies, when it is necessary to give these in a watery mixture. The oil or fat should be well beaten up with the yolk of egg until a smooth homogeneous mixture is formed, and then the warm watery fluid may be gradually added, the beating or stirring being meanwhile vigorously continued until a fine emulsion is formed. The addition of a little alkali facilitates the process.

White of egg is a constituent of Mistura spiritus vini Gallici.

PEPSIN, *P.B.* Pepsin.

A preparation of the mucous lining of the fresh and healthy stomach of the pig, sheep, or calf.

Preparation.—The stomach of the recently killed animal having been cut open, and laid on a board with the inner surface upwards, any adhering portions of food, or other undissolved matter, are to be removed, and the exposed surface slightly washed with cold water; the cleansed mucous membrane is then scraped with a blunt knife or other suitable instrument, and the viscid pulp thus obtained is to be immediately spread over the surface of glass or glazed earthenware, and quickly dried at a temperature not exceeding 100°. The dried residue is to be reduced to powder, and preserved in a stoppered bottle.

Characters and Tests.—A light yellowish-brown powder, having a faint but not disagreeable odour, and a slightly saline taste without any indication of putrescence. Very little soluble in water or spirit. 2 grains with an ounce of water, to which 5 minims of hydrochloric acid have been added, form a mixture in which 100 grains of hard boiled white of egg in thin shavings, will dissolve on their being digested together for about four hours at 98°.

Action and Use.—A substitute for the natural digestive fluid in atony of the stomach from functional derangement or organic disease.

Too much reliance must not be placed upon such a trivial means of supplying a natural function.

Dose.—2 to 5 grains in a little gruel or milk.

LAC, *P.B.* *Milk.*

The fresh milk of the cow, *Bos Taurus*, Linn.

Milk is a natural emulsion, being composed of *butter* diffused through a solution of *casein* and traces of mineral salts. By the microscope the fat is seen to be divided into the minutest spherules everywhere surrounded by a clear fluid. Each little spherule is invested by an albuminous (caseous) envelope, and when this is dissolved by the addition of caustic alkali the spherules soon coalesce, and, separating from the watery fluid, rise to the surface, and form a layer of yellow oil—pure butter. If milk be allowed to remain at rest, the spherules of oil, owing to their comparative levity, rise to the surface, and accumulate there as a layer of *cream.* The addition of a vegetable or mineral acid to milk causes the separation of the casein and most of the butter, which, being commingled, form bulky white clots. The slightly opalescent fluid in which they float is merely water holding the sugar, and such portions of the salts as do not attach themselves to the casein, in solution. This fluid is popularly known as *whey.* Maceration with *rennet* (the dried mucous membrane of the calf's true stomach, see Pepsin) has the same effect, and it is thus used in making *cheese,* which is a mixture of the casein and butter compressed and altered by age. By the process of *churning* the cream, the spherules of fatty matter are forced together, their little caseous envelopes are broken, and the butter is ultimately separated from the *butter-milk,* which contains all the constituents of milk excepting the fat. The sp. gr. of milk varies from 1·030 to 1·035. The quantity of cream (which may be estimated by placing the milk in a graduated tube) should not be less than 5 parts by measure in 100 of milk.

The following table represents the constituents of 100 parts of milk of woman, and of the domestic animals from whom it is derived for the use of infants and sick persons:—

Constituents in 100 parts.	Woman.	Cow.	Ewe.	Goat.	Ass.
Water	88·6	87·4	85·6	82·0	90·5
Butter	2·6	4·0	4·5	4·5	1·4
Sugar and soluble salts...	4·9	5·0	4·2	4.5	6·4
Casein and insoluble salts	3·9	3·6	5·7	9·0	1·7
Sp. gr. varies from.........	1·030 to 1·035		1·035 to 1·041		1·023 to 35

Butter is composed of *olein,* but *palmitin* chiefly. According to Heintz, a portion of the solid constituents is *butin,* which yields on saponification butic acid, $HC_{20}H_{39}O_2$. The characteristic odour and flavour are due to traces of *butyrin, caproin,* and *caprylin,* fats which when saponified yield glycerin and butyric $HC_4H_7O_2$, caproic $HC_6H_{11}O_2$, and caprylic $HC_8H_{15}O_2$ acids respectively.

Butyric acid is a volatile fluid, having the odour of rancid butter, and a sharp acrid taste. It is a powerful local irritant. Caproic acid is also a very pungent fluid, and has the odour of the goat or of sour perspiration. These acids are often developed from butter in disordered states of the digestive organs, and increase the intestinal disturbance. They also exist, pre-formed, in old and especially decayed cheese, conferring upon it its peculiar pungency.

The sugar of milk has been already described, see p. 321.

The salts of woman's milk amount to about 0·2 per cent., that of the cow about 0·7. They are composed of *free soda* and *potash*, associated with the casein so as to prevent its coagulation by heat, and giving an alkaline reaction to the milk; of *potassium* and *sodium chloride;* of *alkaline phosphates*, and of the *phosphates of calcium* and *magnesium.* Hailden discovered 0·47 per cent. of *ferric oxide* in the ash of milk.

Casein is a modification of albumin soluble in solutions of the alkalies, of sodium and ammonium chloride, and of potassic nitrate; the solutions when heated develop a characteristic film or skin of insoluble casein on the exposed surface. A solution of casein is precipitated by rennet and by acetic acid, and these characters, together with the formation of a pellicle when heated, distinguish casein from ordinary albumin.

On exposure to the air at the ordinary summer heat, and especially in thundery weather, the natural alkaline reaction of milk gives way to a decidedly acid one, and then on heating the fluid the casein is precipitated. The acid formed under these circumstances is

Lactic acid, $HC_3H_5O_3 = 90$. It is developed by the agency of casein, which acts as a ferment, from the sugar or lactose, with which it is isomeric. Lactic acid is a constituent, but probably an abnormal constituent, of the body, being found in the juices of the tissues, in the gastric juice, and in the acid sweat. It is a clear, odourless, syrupy liquid, sp. gr. 1·215, of a sharp acrid taste. It is dibasic, and forms soluble crystallisable salts (see p. 213). Lactic acid may be obtained from sour milk by neutralising it with chalk, purifying the lactate of lime by solution and crystallisation, and decomposing it with sulphuric acid, &c. Or carbonate of zinc may be used instead of chalk, and the lactate decomposed by a current of sulphuretted hydrogen. The filtered fluid contains the lactic acid, which may be obtained by evaporation.

Action and Uses.—The nutritive properties of milk are well known. As a source of fat it is usually more suitable than cod liver oil; and as an emulsion it is far superior to those formed with the oil,—the so-called "Pancreatine,"—obtained by æther from the pancreas. If cow's milk be given too freely, or undiluted, it often disagrees with sick persons and young infants, and then large clots of undigested casein are found in the stools. As an article of diet in the sick room, it must therefore be used with discretion, and diluted or skimmed, according to the requirements of the case, and in the treatment of both infants and sick adults recourse may be often had with great advantage to the more dilute milk of the ass. In the treatment of diabetes the concentrated milk of the goat or ewe may be substituted for that of the cow. Milk may be suitably employed as a vehicle in the preparation of many mixtures, such as Mistura scammonii, in which it is prescribed.

FEL BOVINUM. Ox Bile.

Ox-gall was long ago much employed in medicine, and its use has been lately revived. The bile, or secretion of the liver, possesses similar characters in all mammalian animals. It is a viscid, transparent fluid, sp. gr. about 1·026, greenish-yellow, mixing freely with water, with an alkaline reaction, a nauseous and bitter taste. It yields on evaporation about 9 per cent. of solid residue of a fatty nature and waxy consistence. Bile is in fact a natural solution of soap, being composed of two fatty acids, the *glycocholic* and *taurocholic*, in combination with excess of *soda* (0·4 per cent). It also contains a large quantity (0·3 per cent.) of *mucus*, which makes it very ropy; pigment; and a trace of cholesterin. The salts are composed of *chlorides*, *phosphates*, and *lactates*, and amount to about 0·7 per cent.

Glycocholic acid, $HC_{26}H_{42}NO_6$, is the principal constituent. It is a conjugate acid, composed of glycocin $C_2H_5NO_2$, and cholic acid $HC_{24}H_{39}O_5,H_2O$. It crystallises in large white silky needles, bitterish-sweet, slightly soluble in water, and freely in alcohol and æther. It forms crystallisable salts with bases.

Taurocholic acid, $HC_{26}H_{44}NO_7S$, is also a conjugate acid, being composed of cholic acid and taurin $C_2H_7NO_3S$. Taurin is remarkable for containing 25 per cent. of its weight of sulphur.

Both of these biliary acids give, with Pettenkofer's test, a characteristic reaction (see below).

Cholesterin, $C_{26}H_{44}O,H_2O$, is a fatty acid, crystallising in thin rhombic plates. In healthy bile it is an insignificant constituent, but in certain morbid states of the liver it accumulates, forming the concretions known as gall stones, and becomes of serious importance.

1. **Fel Bovinum purificatum**, *P.B.* *Purified Ox Bile.*

The purified gall of the ox, *Bos Taurus*, Linn.

Preparation.—Mix 1 pint of *fresh ox bile* with 2 pints of *rectified spirit* by agitation in a bottle, and set aside for twelve hours until the sediment subsides. Decant the clear solution, and evaporate it in a porcelain dish by the heat of a water bath, until it acquires a suitable consistence for forming pills.

The bile is thus freed from mucus, all the other constituents being retained.

Characters and Tests.—A yellowish-green substance having a taste partly sweet, and partly bitter, soluble in water and in spirit. A solution of one or two grains of it, in about a fluid drachm of water, when treated, first with a drop of freshly-made syrup consisting of one part of sugar and four of water, and then with sulphuric acid cautiously added until the precipitate at first formed is redissolved, gradually acquires a cherry-red colour, which changes in succession to carmine, purple, and violet. (This is Pettenkofer's test for the biliary acids. The reaction depends upon the presence of cholic acid.) The watery solution of bile should give no precipitate (mucus) on the addition of rectified spirit.

Action and Uses.—Bile is essential to digestion in several ways. It neutralises the acid chyme, facilitates the emulsification of fat and its absorption by the lacteals, prevents by its antiseptic powers the decomposition of the chyme in its passage along the intestines, and acts as a natural purgative. It is employed in morbid states of the liver in which there is defective secretion, and in constipation. In order to replace the natural secretion to any extent, larger quantities than those prescribed by the Pharmacopœia must be taken.

Dose.—10 to 60 grains, in the form of pills, three hours after meals.

MOSCHUS MOSCHIFERUS, *Linn.* The Musk Deer.

This elegant little animal differs from its cervine allies by the absence of horns. It is about the size of the goat, with a slender body clothed in greyish-brown fur interspersed with coarse whitish hairs. The tail is very short. The male has two long superior canines curved towards the neck, and is provided with a pouch (musk sac) placed in front of the preputial orifice.

It inhabits the mountainous regions of Central Asia from Thibet to China, and is found on the tops of difficultly-accessible and generally open mountains, usually in the neighbourhood of the snow, but comes nearer to the plains, according to the inclemency of the seasons, and springs from rock to rock with great agility.

The musk sac is flat, smooth, and naked, above, where it is applied against the abdomen,—convex below, and hairy. The musk is secreted by small glands, situated in little pits in the mucous membrane. It is most abundant in the rutting season, and when fresh is soft, and of a reddish-brown colour. When dried, and contained in its native sacs, it forms the musk of commerce.

It is singular that the common Hindoo name of the musk, and in the Himalayas that of the musk animal, is *kustooree*, a name similar to castoreum, a substance which musk so closely resembles in origin. The name *musk* is no doubt derived from the Arabic *mishk*, or *mooshk*, which is evidently the same word as the Sanscrit *mooshka*. This has been used as a perfume and as a medicine by the Hindoos from very early times. It seems to have been adopted from the Hindoos by Serapion, but it was previously mentioned by Ætius.

Moschus, *P.B.* *Musk.*

The inspissated and dried secretions from the preputial follicles. Imported from China and India.

Characters and Constituents.—In irregular reddish-black, rather unctuous grains; having a strong, very diffusible musk odour, and a bitter aromatic taste; contained in a round or slightly oval membranous sac, about 2 inches in diameter, curved on the outer side with stiff greyish hairs arranged in a concentric manner around its central orifice. The sacs weigh about ¾ of an ounce, and the contained musk 160 grains.

Musk is composed of fatty and albuminous matter with epithelium. *Stearin*, *olein*, *cholesterin*, *albumin*, and *free ammonia* are readily separated. The essential constituent, the *odoriferous principle*, is however incapable of isolation. It is attached to the ammonia, and is dissipated by heat.

Varieties and Adulterations.—There are two kinds of musk:—1. **Chinese**, which is that described above; 2. **Siberian or Russian.**—This is an inferior kind; the pods are longer, and the musk is less powerful, and of a disagreeable odour. 3. **Artificial Musk.**—This is manufactured extensively by the Chinese merchants of Canton. It is said to be composed of a mixture of dried blood and ammonia, with a small quantity of musk, sewed up in a piece of the skin of the musk ox.

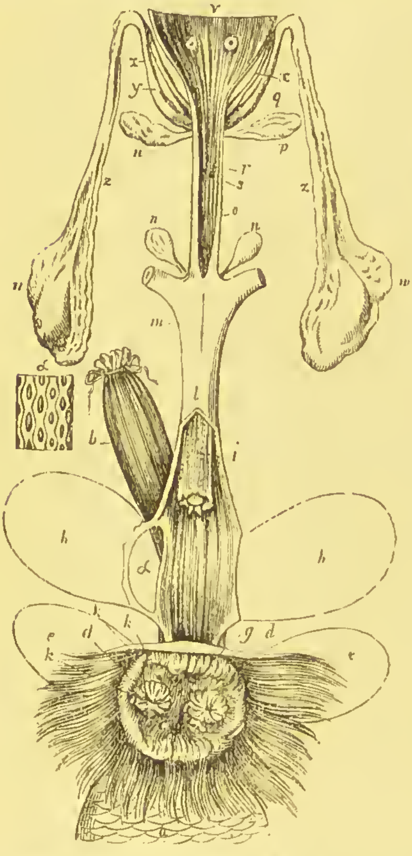

Fig. 139.—*Castor fiber*. Male genital organs.

Action and Uses.—Musk is supposed to be a nerve stimulant and aphrodisiac. It has been recommended as an antispasmodic and diffusible stimulant, and given in hysteria, chorea, and allied nervous disorders. We have no evidence to offer in support of this recommendation and practice.

Dose.—5 to 10 grains in milk.

CASTOR FIBER, *Linn.* The Beaver.

The description by Dioscorides leaves no doubt about this animal, which is so interesting and remarkable for its *building* habits in North America, though those of Northern Europe, from *burrowing*, are supposed to constitute distinct species; but Cuvier states, that after the most scrupulous comparison of the beavers which burrow along the Rhone, the Danube, and the Weser, he has been unable to find any characters to distinguish them from those of North America. The beaver is particularly distinguished from other Rodentia by its nearly oval tail (*a*), which is flattened horizontally, and covered with scales. It is peculiar also in the castor-sacs, which are found both in the male and female, and of which a detailed account is given by Brandt and Ratzeburg. From them the accompanying illustration has been copied. The castor-sacs (*h h*) are often confounded with the testicles (*w w*), and their position is difficult to understand. They can be distinctly seen only on the removal of the skin of the abdomen. Besides these there are two others (*e e*), which are oil-sacs. All are situated between the pubic arch and the cloaca, a common hollow which is covered by a wrinkled hairy protuberance, into which open the oil and castor-sacs, the rectum (*b*), and prepuce (*i.*) The castor-sacs are somewhat pear-shaped and compressed: they communicate by the same opening at their narrow extremities, but diverge in front. Like the musk-bags, these sacs have several coats; within all there is a convoluted mucous membrane, covered with scales, and a small brownish body, supposed to be a gland. The secretion, or castor contained in these sacs, is at first of a yellow-orange colour, but changes to a brownish colour as it becomes exposed to the air.

1. **Castoreum,** *P.B.* *Castor.*

The dried preputial follicles of the animal described, separated from the somewhat shorter and smaller oil-sacs which are frequently attached to them. From the Hudson's Bay territory.

Characters and Constituents.—Follicles in pairs, about 3 inches long, fig-shaped, firm and heavy, brown or greyish-black; containing a dry resinous reddish-brown or brown, highly odorous secretion, in great part soluble in rectified spirit and in æther.

It is composed of *volatile oil*, *resin*, *castorin*, with fatty, albuminous, and saline matters mixed with epithelial debris. The volatile oil is colourless, or nearly so, of an acrid bitter taste, and the odour of castor. According to Wöhler, it contains both phenic acid and salicin. The resin is amorphous, dark-brown, bitter, and slightly acrid; and is soluble in alcohol, but not in æther. Castorin is a colourless crystalline, non-saponifiable fat, resembling cholesterin. It is odourless and tasteless, and is soluble in æther and in boiling alcohol.

Action and Uses.—Castor appears to resemble in its action the fœtid gum resins, such as galbanum, and is reputed to be like these, antispasmodic. It is employed as such in hysteria, chorea, and epilepsy associated with sexual disorder. It is also supposed to be an emmenagogue. The following tincture is a suitable form for administration, but as the taste is disagreeable it may be given in the form of pill.

Dose.—5 to 10 grains.

2. **Tinctura Castorei,** *P.B.* *Tincture of Castor.*

Prepared by macerating 1 ounce of *castor* in coarse powder, in 1 pint of *rectified spirit*, agitating occasionally, straining, pressing, filtering, and adding sufficient rectified spirit to make 1 pint.

It is a dark brown fluid, having the heavy disagreeable taste and odour of the drug.

Dose.—1 to 4 fluid drachms.

CLASSIFICATION OF REMEDIES.

Restoratives.
Tonics.
Alteratives.
Astringents.
Diluents.
Demulcents.
Emollients.
Diuretics.
Refrigerants.
Antilithics.
Expectorants.
Sialagogues.
Errhines.
Emetics.
Cathartics.
Anthelmintics.
Emmenagogues.
Caustics.
External Stimulants.
Internal Stimulants.
Anæsthesiants.
Narcotics.
Spasmodics.
Antispasmodics.
Depressents.
Antiseptics.
Disinfectants.

RESTORATIVES.

All bodies which contribute to the restoration of the tissues and fluids of the body are included in this category.

1. **Food and Air.**—Albumin, Gelatin, Starch, Fat, Sugar, Water, Oxygen, and Nitrogen, and a due proportion of the following.
2. **Mineral Compounds.**—Of Potash, Soda, Lime, Magnesia, Silica, Sulphur, Phosphorus, Chlorine, and Iron.

One constituent of the bile contains 25 per cent. of sulphur, and the blood contains a small quantity of iron. The need of these constituents, small as is their proportion to that of the whole body, is well exemplified in the direct and speedy improvement which compounds of iron effect in anæmia; and what is true of this constituent of the body is, doubtless, applicable to all.

TONICS. Τείνω, to tighten.

1. **Astringents** (see p. 509). All classes of astringents are more or less tonic.
2. **Vegetable Tonics.**—α. *Simple bitters*—Beberia, Berberina, Quassia, Calumba, Gentian, Chiretta, Menyanthes, Erythræa, Cetraria, Pareira, Salicin, Narcotine.
   β. *Bitters having in large doses an individual action*—Quinia and its associated alkaloids, Strychnia and Brucia, Prunus Virginiana.
   γ. *Aromatic tonics*—Anthemis, Aristolochia, Artemisia, Aurantium, Cascarilla, Cusparia or Angostura, Lupulus, Serpentaria.
3. **Mineral Tonics.**—The dilute mineral acids, Iron and its preparations, chalybeate mineral waters (see p. 47), sulphate, oxyde and valerianate of Zinc; sulphate and ammonio-sulphate of Copper; Arsenious acid and its preparations, Arseniate of iron; oxyde and nitrate of Silver.

Tonics gradually increase the tone of the muscular fibre when relaxed, and the vigour of the body when weakened by disease. Though resembling astringents in some of their effects, they do not produce corrugation when properly diluted. Acting like astringents on the nervous system, they give tone, without exciting increased activity, their effects are more permanent than mere nerve stimulants, and their use is not followed by exhaustion (see action of quinine, p. 568). When a tonic is fitly prescribed, as in a case of debility, its effects are gradually perceived; the energy of the stomach and the appetite are increased, digestion is facilitated, the force of the circulation augmented without corresponding quickness, and the respiration becomes fuller and more vigorous. In consequence of the more healthful performance of these functions, nutrition becomes necessarily more perfect. Absorption is performed with more vigour, as is evident in the constipation which usually follows the successful exhibition of tonics, and is soon perceptible in other parts, causing the œdematous swellings of invalids to disappear. Secretions become more natural, inordinate and partial sweats disappear, the skin returns to its normal state of softness, and the countenance resumes the natural glow of health. The senses and all the faculties become more active, and the strength increased. Thus the patient, labouring under sheer debility, or recovering from acute disease, or the effects of depressing and evacuating remedies, is restored to pristine health and energy.

ALTERATIVES.

1. **Mineral.**—Acidum arsenicum, A. arseniosum and salts of arsenic; Mercurial salts, Iodine, Bromine, and Chlorine, and their compounds; Acidum phosphoricum, A. nitrohydrochloricum, A. boracicum; Antimonial compounds, Potash.
2. **Vegetable and Animal.**—Colchicum, Veratrum, Guaiacum, Mezereum, Sarsaparilla, Sassafras, Taraxacum, Oleum morrhuæ.

The term *alterative*, so commonly employed, is differently interpreted by different authors. Müller includes under it all such remedies as are neither stimulant nor sedative, and have the power of effecting changes in the state of the living solids, and consequently in the functions which they perform. The term is, however, usually applied to such as, taken in comparatively small doses, and continued for some time, by degrees and almost without any perceptible effect, produce changes in the secretions and in disordered actions. Others consider them as stimulants which act specially upon particular glands and upon absorption in general. Bouchardat defines alteratives as medicines which are absorbed, and which act by modifying in a permanent manner the motions of the blood and of the different secretions. According to this view they nearly coincide with Dr Headland's subdivision, catalytica, of hæmatica, or blood-medicines, all of which "act while in the blood, which they influence;" but the catalytics "act so as to counteract a morbid material or process, and must pass out of the body."

ASTRINGENTS. *Ad stringo*, to bind, to contract.

1. **Cold.**—The cold bath, ice and water, freezing mixtures (1 part each of nitrate of potash and chloride of ammonium and 2

parts of water reduce the temperature 40°, or from 50° to 10°; equal parts of nitrate of ammonia and water give 46° of cold, that is reduces the temperature from 50° to 4°; 2 parts of pounded ice or snow and 1 part of common salt gives a mixture of the temperature − 4°).

2. **Vegetable Astringents.**—Catechu, Cinchona, especially *C. pallida*, Granati cortex, fructus, et radicis; Hæmatoxylum, Kino, Krameria, Quercus, Gallæ, Tormentilla, Rosa Gallica, Uva-ursi, Ulmus—and their preparations; Tannic and Gallic acids.

3. **Mineral Astringents.**—The dilute mineral acids, all styptics (see p. 818), Cadmii iodidum, Tinctura ferri perchloridi, Liquor ferri pernitratis, Ferri sulphas, Plumbi acetas, Zinci acetas et sulphas, Creta. Liquor calcis, Liquor calcis saccharatus, Bismuthi subnitras.

Astringents corrugate or produce a contraction of the muscular fibres of the part to which they are applied, and coagulate or precipitate albuminous and gelatinous fluids. The astringency of any substance is easily recognised by corrugation of the papillæ of the tongue when brought in contact with it; but otherwise there is no principle common to the whole, some being mineral acids, others metallic salts, with the earthy salt alum, while many are obtained from the vegetable kingdom; but all have the power of coagulating albumen. The first effect of an astringent (then called styptic) is visible when brought into contact with a bleeding wound, in the contraction which stops the bleeding from small vessels, by constricting the muscular fibre of their coats. In this way, when applied to mucous surfaces, they diminish secretion. But, like other chemically acting remedies, they have a further action, by diminishing relaxation and thus giving a tone to the stomach, and thence, acting dynamically, they produce a powerful effect on the system. They thus obviate general debility, act as permanent stimulants, and assist in curing intermittents, though their first effects appear of so local a nature. Some are, no doubt, absorbed into the blood, and being thus circulated, produce their constringent effect on the capillaries and parenchamatous organs, diminishing the secretions of the glands. See "Chalk" and "Tannic acid" for further remarks on the action of astringents.

DILUENTS. *Diluo*, to wash, to make fluid.

1. **Aqueous Fluids.**—Water, especially distilled water; potash, soda, and aërated waters; the mineral waters.

2. **Fluid Diet.**—Rice water, barley water, thin gruel; broths, including weak beef tea; whey.

These remedies are rapidly absorbed, and dilute the blood. But as this fluid bears only a temporary dilution the excess of water is speedily removed by the lungs, the kidneys, and the skin. Water may therefore be regarded as the natural stimulant of these secretory organs. In its passage through the blood, water exercises a solvent action and carries with it some portions of its solid constituents, thus exercising an eliminative action. The continued imbibition of large quantities of water relieves the blood of any excess of solids, but in a state of health may cause undue impoverishment. Fluid articles of diet act as diluents, and in the treatment of disease we must use them judiciously, and not continue them too long, especially during convalescence, when there is need of improvement in the quality of the blood, the solid constituents of which being often reduced to the lowest proportion consistent with life.

DEMULCENTS. *Demulceo*, to stroke, to caress.

1. **Mucilaginous.**—Decoctum altheæ, D. malvæ, D. cetrariæ, D. plocariæ; Infusum cydoniæ seminum, I. lini, I. ulmi fulvæ; Mucilago acaciæ, M. tragacanthæ.
2. **Amylaceous.**—Mucilago amyli—in various forms, as arrowroot, tous-les-mois, salep, tapioca, sago; Decoctum avenæ, D. hordei.
3. **Oleaginous.**—Oils generally, especially almond, olive, arachis, linseed, and cocoa oils; Animal oils and fats, especially neatsfoot oil (obtained in boiling tripe and cow-heels); Cream, Butter, Lard, Suet, Wax, and Spermaceti.
4. **Composite.**—Almond mixture, Milk, thin Jelly sweetened, Gelatine lozenges, Liquorice, pate de Guimauve, pate de Jujube, Manna, Figs.

A demulcent is an internal emollient; it soothes and softens the part with which it comes in contact. This class of remedies is only useful, therefore, in dry, irritable, or inflamed conditions of the mucous membranes—of the eye, the nose, the mouth, fauces, gullet, stomach, intestines, especially the rectum, and the genito-urinary passages. After absorption they have only a diluent action, excepting indeed the oleaginous demulcents which are absorbed unchanged, and may therefore exercise a general demulcent action on the inner surface of the blood-vessels in irritable conditions, such as rheumatic fever and chorea.

EMOLLIENTS. *Emollio*, to soften.

1. **Moist Heat.**—Hot fomentations of water, decoction of poppies, or infusion of slippery-elm, applied by means of flannel, spongio-piline, or a sponge; Cataplasma lini, C. panis, C. caroti, C. chondri, C. carbonis.
2. **Oleaginous and Saponaceous.**—Those given under demulcents. Glycerin soap, Palm-oil, Unguentum cetacei, U. simplicis, U. zinci; Linimentum calcis, L. opii, L. potassii iodidi cum sapone, L. saponis.

3. **Mechanical.**—Carbonate of zinc (calamine), Fuller's earth, French chalk, Starch powder, carded Cotton.

These remedies act in several ways, but to one end—the relaxation, softening, and soothing of a part. Thus cotton or soapstone powder, by soothing an excoriated part and rendering its motions not only painless but easy, removes the irritability which maintains the vascularity and painful turgidity of a part. Hot fomentations and the inunction of warm oil relax, the first the muscular fibres, of a sphincter for example, and the second the part to which it is applied, rendering it supple by the imbibition of its oily particles, both simultaneously relieving the nervous irritability which keeps up the contraction of the part.

DIURETICS. *Δια οὖρον*, by way of the urine.

1. **Cold.**—When applied to the surface, whether as cold air or water, it produces in the healthy subject free diuresis.
2. **All Diluents** (p. 810), and **Diaphoretics** (p. 813), when they fail to excite the action of the skin, and especially classes 4, 5, and 6, and 8. Indeed, the primary action of the volatile oils, such as Turpentine, Juniper, Squill, and of Serpentary and Digitalis, is diuretic. The preparations of Broom and Pareira, Asparagus, Belladonna, Cantharides.
3. **Salines.**—In addition to those given under 4 Diaphoretics, are the following:—Liquor potassæ and the soluble salts of potash, especially the acetate, citrate, tartrate and acid tartrate, the nitrate and carbonate; the corresponding salts of soda; soap.
4. **Hydragogue Purgatives** (see p. 816).—These, by relieving congestion of the kidneys, act indirectly as powerful diuretics. Venesection is also followed by the same result when the blood-vessels are distended and the pressure is high.
5. **Mercurials**, by relieving biliary congestion, remove congestion of the portal system of blood-vessels and secondary congestion of the kidneys, and thus produce diuresis.

Diuretics are those remedies which increase the total quantity of urine, and those best deserve the name which not only increase the quantity of urine, but also the amount of the solid matters, as I have shown to be the case with belladonna and henbane (*Old Veget. Neur.* pp. 267, 320).

It has been already stated that the two great functions of the skin and kidneys on many occasions mutually supply the place of, and alternate with each other, and that frequently the causes which favour the secretion of the one will interfere with that of the other. It follows, therefore, that an opposite course often requires to be followed with regard to the establishment and maintenance of these two effects—diaphoresis and diuresis. To secure the latter the skin must be kept moderately cool. Therefore the day-time is frequently the best time for the exhibition of diuretics. Their action is assisted by coldness and dampness of the atmosphere, and also by the moderate, not excessive, use of diluents; and is impeded, as the secretion of urine itself is, by too free an action of the bowels or of the skin, as well as by whatever increases plethora and pressure on the circulation, or promotes congestion in the liver or in the kidney itself. As the action of some diuretics is incompatible with that of others, it is absolutely necessary to pay attention to the peculiar mode of action of each.

DIAPHORETICS. *Διαφορέω*, to dissipate, disperse.

1. **Hot Diluents** (see p. 810), including hot infusions of tea, mint, sage, and the like.
2. **Hot Baths.**—Of water, at 100° to 106°; of aqueous vapour, at 120° to 160°; of air, at 120° to 160°.
3. **Alcoholic and Ætherial Remedies.**—Brandy, whisky, and gin diluted with hot water; Æther; Spiritus ætheris, Spiritus ætheris nitrosi, Chloroform; Spiritus chloroformi, Spiritus ammoniæ compositus, Chloral hydras.
4. **Salines.**—Liquor ammoniæ acetatis, Liquor ammoniæ citratis, Ammoniæ carbonas, Potassæ nitras.
5. **Stimulants.**—Volatile oils, Oleo-resins; Resins, Sulphur, Oleum sulphuris; oils of Turpentine, Cajuput, Juniper, Rue, Cubebs, Copaiba; Guaiacum, Jaborandi, Angostura, Buchu, Sassafras, Saffron, Armoracia.
6. **Opiates.**—Opium, Apomorphia, Codeia; Pulvis ipecacuanhæ compositus.
7. **Nauseants.**—Ipecacuanha, Squill, Pilula ipecacuanhæ cum scilla, Colchicum, Digitalis, Senega, Violet, Serpentary.
8. **Antimonials.**—Antimonium tartaratum, Antimonii oxydum, Pulvis antimonii compositus, Antimonium sulphuratum.
9. **Mercurials.**—Pilula hydrargyri, Pilula hydrargyri subchloridi composita.

Diaphoretics or sudorifics (*sudor*, sweat) increase exhalation from the surface, and the natural function of perspiration. The function of perspiration prevents undue exaltation of temperature, and eliminates carbonic acid, water, and even the constituents of the urine from the blood. Like the secretion of urine, it varies in the same individual at different times and under different conditions, such as the state of the constitution, the nature of the food, the temperature, dryness, or rarefaction, moisture, or coldness of the atmosphere. The action of a diaphoretic is influenced by the same circumstances. Hence it frequently depends entirely upon keeping the patient in bed, for when the skin is exposed to the cool air a diaphoretic remedy acts as a diuretic. The two functions, diuresis and diaphoresis, are indeed vicarious one of the other; and therefore, when diaphoretics act freely, the quantity of urine is diminished. Some act by at once relaxing the surface, others act at first as general stimulants.

REFRIGERANTS. *Refrigero*, to cool.

This term is applied to remedies which diminish the heat of the body in the pyrexial state. They consist of diluents—the saline diaphoretics, cool drinks, and evaporating lotions.

ANTILITHICS. Αντι, λίθος, a stone.

1. **Diluents** (see p. 810).—Especially soda, potash, lithia and Vichy waters, in one form of gravel.
2. **Alkalies.**—Potash, soda, lithia, lime.
3. **Acids.**—The mineral and vegetable acids.
4. **Salts.**—Phosphate and biborate of soda, Benzoate of ammonia; the Acetates, Citrates, and Tartrates of soda, potash, and lithia, which are eliminated as carbonates, rendering the urine alkaline.

There are, in reference to these remedies, which are also called "Lithontriptics," three kinds of calculi or gravel—*a.* the phosphatic, attended by an alkaline condition of the urine; *b*, the uric; and *c*, the oxalic, both associated with an acid state of the urine. In the first, acids are the appropriate remedies, and experience has proved that the uncombined vegetable acids restore the acidity of the urine sooner than the mineral ones. In the uric diathesis, alkalies are required, and as a rule it is best to give them in combination with the vegetable acids. Phosphate and benzoate of ammonia are also recommended. In the oxalic diathesis, nitromuriatic acid, or nitric acid alone, is the most fitting remedy.

Alkalies and acids are sometimes injected into the bladder with the view of directly dissolving uric acid and phosphatic calculi respectively.

EXPECTORANTS, *Expectoro* (*ex*, *pectus*), to throw off from the chest.

1. **Inhalations** of steam, alone or impregnated with turpentine, kreasote, cajuput, camphor.
2. **Hot Demulcents** (see p. 811), especially those of a mucilaginous nature.
3. **Stimulant Expectorants.**—Ipecacuanha (small doses) Squill, Senega, Elemi, Myrrh, Ammoniacum, Galbanum, Assafœtida; Balsam of Tolu, Peru, and Copaiba; Styrax, Benzoin, Benzoic acid, Cascarilla, Angostura, Oleum sulphuratum. The volatile Oils of turpentine, juniper, mint, cajuput, &c.
4. **Depressent Expectorants** or **Nauseants.**—Moderate doses of the drugs mentioned under Emetics, class 2 (see below).

Expectorants, such as hot fomentations to the throat or hot inhalations; hot demulcent drinks, which act as fomentations to the back of the larynx and windpipe; and lozenges, which incite by reflex action a flow from the surfaces with and near which they come in contact, act locally: the remainder act generally, being absorbed into the blood, and subsequently eliminated by the lungs and general mucous surface including that of the bronchial tubes, and thereby increasing secretion from the mucous glands.

SIALAGOGUES. Πτύελον, saliva; ἄγω, to induce.

1. **Masticatories.**—India-rubber, Wood, Areca nut, Mastich.
2. **Local.**—Jaborandi, Xanthoxylum clava, Pyrethrum, Mezereum, Capsicum, Piper nigrum et longum, Sinapis, Armoracia, strong acids, vapour of Æther. Essential oils, such as that of cloves and kreasote.
3. **General.**—Pilocarpus and Xanthoxylum, Iodide of potassium, Mercurial preparations.

Mastication alone excites a flow of saliva. Stimulants induce the flow by their impressions on the oral branches of the fifth nerve. Mercury and iodine excite the flow in the process of elimination. This class of medicines is beneficial in relieving neuralgic affections of the head and face.

ERRHINES and STERNUTAMENTS. ’Εν, ‘ρίν, the nose, or *sternutamentum*, that which excites sneezing.

1. **Aromatic Errhines.**—The dried leaves of aromatic plants, as Melissa, Lavandula, Rosmarinus, Origanum, Teucrium marum (headache plant). Powdered orris root, Ammonia, Acetic acid, Asarum.
2. **Acrid Errhines.**—Powdered ipecacuanha, powdered Veratrum root, Veratria, Euphorbium resin, Subsulphate of mercury, Mercurial and Chlorinous fumes. Nicotianum tabacum (various kinds of snuffs).

The term errhine is confined to those remedies which induce a flux from the nose without producing sneezing. Sternutaments are those which excite this reflex act.

They are very useful in relieving, by a flux of mucus, painful or injurious tension of the vessels of the head.

EMETICS. ’Εμέω, to vomit.

1. **Irritant Emetics.**—Hot (105° to 120°) water. Hot water containing ammonia, common salt, mustard and water, sulphate of zinc, sulphate of copper.
2. **Depressent Emetics.**—Ipecacuanha, Violet root, Apomorphia, Squill, Veratrum viride, Colchicum, Hellebore, Lobelia, Tobacco, Tartarised antimony.

Of the medicines above enumerated emesis or vomiting cannot be safely induced by lobelia or tobacco, and these, as also veratrum, hellebore, and colchicum, produce both vomiting and purging. Indeed, this is true of all emetics which pass the stomach; and in order to produce prompt emesis the dose should be a full one, so as to quickly excite the stomach. For this purpose, mustard and sulphate of copper are of the irritant emetics, and ipecacuanha and tartarised antimony of the depressent ones the most suitable. Members of the former class should be given in poisoning where there is blunted sensibility, and those of the latter in poisoning before depression of the vital powers has occurred, or in diseases where it is desired to obtain a depressing, relaxing, or sudorific effect.

CATHARTICS or PURGATIVES. Καθαίρω, to purge.

1. **Laxatives.**—Remedies which merely promote the peristaltic action of the bowels, and slightly increase the moisture of the fæces, and thus soften them without rendering them pultaceous or liquid. Sulphur sublimatum et precipitatum, Fel bovinum purificatum, Manna, Fici pulpa, Pruni pulpa, Oleum amygdalæ et olivæ, simple Enemata.

2. **Aperients.**—Remedies which accelerate the action of the bowels, and produce soft or moderately liquid stools according to the dose. Oleum ricini, Hydrargyrum cum creta, Hydrargyri pilula, Magnesia, Magnesiæ carbonas, Magnesiæ carbonatis liquor, Magnesiæ sulphatis, Rhamnus frangula, Rheum, Rhei infusum, Rhei pilula composita, Rhei pulvis compositus, Rhei syrupus, Rhei tinctura, Sennæ confectio, Sennæ syrupus, Pulvis glycyrrhizæ compositus, Sennæ infusum, Sennæ mistura composita, Potassæ sulphas, Potassæ tartras, Soda tartarata, Sodæ sulphas, Sodæ phosphas; the preparations of Aloes, and Tamarind, purgative Enemata.

3. **Cholagogue Purgatives.**—All brisk aperients, but especially Pilula hydrargyri, Hydrargyrum cum creta, Hydrargyri subchloridum, Pilula hydrargyri subchloridi, Aloes, Colocynth. Podophyllum, Hellebore.

4. **Hydragogue Purgatives.**—Jalap, Scammony, Colocynth, Buckthorn, Hellebore, Veratrum, Colchicum, Gamboge, Podophyllum, Croton oil, Elaterium, and their preparations; Subsulphate of mercury.

In the present day the use of purgatives has taken the place of venesection. When the plethora is due only to water, we may secure as great, and almost as speedy, a relief to the overloaded blood-vessels by a free purge as by blood-letting; and by the frequent repetition of the drug we may impoverish and diminish the blood, by preventing too great an absorption of blood-making materials from the alimentary canal. But there will still remain a number of conditions for which purgation cannot safely be substituted, and in which immediate benefit results from the direct loss of blood. As a relief to the portal circulation, and the congestion of the liver and spleen, and secondarily of the kidneys which accompanies it, purgatives are most beneficially employed. Generally in all internal congestions their use is necessary; and in congestive and inflammatory diseases of the brain they are given, not only as depletives to diminish the quantity of the blood and the arterial pressure, but also as counter-irritants, for during the action of a hydragogue purge a much larger quantity of blood is distributed to the great intestinal surface than in the quiescent state of the bowels. Purgatives are the most valuable means we possess of relieving the system from dropsical effusions. There are few diseases, indeed, in which the use of purgatives is not required, and much experience of their action will be needed in order to make a judicious selection.

ANTHELMINTICS. Αντι, against; ἕλμινς, νθος, an earthworm.

1. **Expelling Tænia and Bothriocephalus.**—Extractum filicis liquidum, Oleum terebinthinæ, Kousso, Kamala, Granati cortex radicis.
2. **Expelling Lumbricus.**—Santonica, Mucuna, Oleum terebinthinæ; Cathartics generally.
3. **Expelling Ascarides.**—All the medicines enumerated in the previous two classes. Enemata of strong solution of sodium chloride, of lime water, and of bitter infusions (quassia, wormwood, tansy, chamomile, and the like).
4. **Destroying Bilharzia** in the bladder, and possibly in the blood, injections of Iodide of potassium.

These remedies are fully treated of under their several heads.

EMMENAGOGUES. 'Eν, at; μήνη, the month; ἀγω, to induce.

1. **General.**—Brisk exercise in the open air; cupping on the loins; leeches on the groins, vulva, or anus; hot hip-baths, hot mustard baths for the legs and feet; general stimulants (see p. 819).
2. **Special.**—Aloetic purgatives, followed by chalybeate tonics; Myrrh, Assafœtida, Copaiba, Hellebore, Juniper, Savine, Rue, Cantharides, Ergot.

These medicines are considered to have the power of promoting the menstrual discharge when either retained or suspended. As amenorrhœa is sometimes the primary cause, and at other times the consequence of some other disease, the treatment necessarily differs, especially as amenorrhœa is often dependent on a want of constitutional energy in an anæmic or plethoric state, often accompanied by irritation of the uterine system. In either case attempts must first be made to restore the constitution to a natural state, and then to prescribe those remedies, all more or less stimulant, which are considered to have a specific effect as emmenagogues.

ESCHAROTICS or **CAUSTICS.** 'Εσχάρα, a hearth or fireplace; and Καυστικὸς (καίω, f. i. act. καύσω, I will burn), caustic.

1. **Heat.**—Applied by means of hot iron, or the moxa (pith soaked in solution of nitrate of potash, dried, and cut into small cakes), and the galvano-cautery.
2. **Acids.**—A. sulphuricum, A. nitricum, A. hydrofluoricum, A. aceticum, A. arseniosum.
3. **Bases.**—Liquor ammoniæ fortior, Potassa caustica, Soda caustica, Calx (calx recens usta), Potassa cum calce, Hydrargyri oxydum rubrum, Lotio hydrargyri flava, Hydrargyri oxydum nigrum, Lotio hydrargyri nigra.
4. **Salts.**—Argenti nitras, Zinci chloridum, Hydrargyri perchloridum, Liquor hydrargyri nitratis acidus, Hydrargyri iodidum rubrum, Liquor antimonii terchloridi, Cupri sulphas, Zinci sulphas exsiccata, Cupri subacetas, Cupri acetas (Linimentum æruginis), Alumen exsiccatum.

Caustics completely destroy the part to which they are applied. Their action and use are treated of under Potassa caustica, Argenti nitras, Zinci chloridum, Hydrargyri perchloridum, Acidum arseniosum, &c.

STYPTICS. Στυπτικὸς (στύφω, to bind or shrivel up).

1. **Caustics** (see above).—All caustics, when sufficiently diluted, are only styptic.
2. **Acids.**—A. oxalicum, A. hydrochloricum, A. carbolicum, A. salicylicum, A. tannicum, A. chromicum.
3. **Bases** and **Salts.**—Calcis hydras, Zinci sulphas, Alumen, Plumbi acetas, Plumbi nitras, Ferri sulphas, and most metallic salts.
4. **Alcohol.**

Strong styptics, such as sulphate of copper, act as mild caustics, by destroying the surface with which they come in contact. Weaker ones, such as sulphate of zinc, merely coagulate the albuminous fluids and beneath the surface have an astringent effect. Taken internally the styptics are caustic to the soft mucous membrane.

STIMULANTS—EXTERNAL.

1. **Rubefacients.**—Acetum cantharidis, Acidum aceticum, and the dilute mineral acids, Armoraciæ radix, Linimentum ammoniæ, L. camphoræ, L. camphoræ compositum, L. chloroformi, L. hydrargyri, L. iodinii, L. saponis, L. sinapis compositum, L. terebinthinæ, L. t. aceticum.

   Emplastrum ammoniaci cum hydrargyro, E. galbani, E. picis, E. resinæ, E. calefaciens, Mezerei extractum æthereum; the volatile oils, of which oil of turpentine is the type; Phosphorus; the Turpentines and Resins; Sinapis cataplasma; the several spirits; Sulphuris iodidum, Tinctura arnicæ, T.

cantharidis, T. capsici; Antimonial, Mercurial, and Iodine ointments.

2. **Epispastics** (*επισπάω*, to draw) or **Vesicants.**—Charta epispastica, Liquor epispasticus, Emplastrum cantharidis, Linimentum crotonis, Oleum sinapis.

3. **Caustics.**—(See p. 818).

Rubefacients, as their name indicates, produce redness of the skin, with warmth and increased sensibility, &c. If long applied, or more concentrated, vesication will ensue; and on continuance of the application, a suppurative discharge. Blisters too long applied to the delicate skins of weakly children in low states, sometimes act as caustics.

STIMULANTS—INTERNAL.

1. **Natural Stimulants.**—A dry cold air, exercise and food, heat.

2. **General Stimulants.**—Ammoniæ carbonas, Liquor ammoniæ acetatis et citratis, Spiritus ammoniæ compositus, Atropia, Alcohol, Opium, Æther, Spiritus ætheris compositus, Æther aceticus, Spiritus ætheris nitrosi, Chloroformum, the Volatile oils, and Aromatic tonics (see p. 808), Valerian, Moschus, Radix sumbul, Castor, Phosphorus.

3. **External Stimulants.**—These are Caustics (p. 818), Styptics (p. 818), Vesicants and Rubefacients (see above), and Electricity.

4. **Special Stimulants.**—*α*, *acting through the moter nerves on the voluntary muscles*—Strychnia, Brucia, Thebaia, Codeia, Theine.
   β, *acting through the sympathetic nerves on the involuntary muscles*—Ergot, Digitalis, Atropia, Hyoscyamia.

5. **Cerebral.**—Alcoholic and ætherial fluids, Chloroform, Opium, Henbane, Indian hemp.

6. **Carminatives.**—Medicines which, by a gentle stimulant action on the stomach and intestinal mucous membrane, excite the contraction of the muscular coat and expel flatus. These are Compound spirit of ammonia, Æther, hot Brandy and water, Peppermint, Cinnamon, Nutmeg; Essential oils and waters, such as Dill, derived from the umbelliferous fruits; Assafœtida, and the other fœtid gum resins, Rue.

Under the influence of general stimulants, the force and rapidity of the circulation is increased, and the various functions of the body are correspondingly accelerated, the temperature is raised, and the secretions are more abundant. After the action is over, if it have been excessive, there is a corresponding period of quietude or depression, and hence a frequent repetition of the stimulant is needed to sustain its effects. (For further information respecting the action of these remedies, see Alcohol, Atropia, Strychnia, Ergot, and Digitalis.)

ANÆSTHESIANTS. A, privative; ἄισθησις, sensation.

1. **General.**—Nitrous oxyde gas, Æther, Chloroform, Chloral hydrate, Bichloride of methylene, Amylene, Nitrate of amyl, Opium, Alcohol, and all Narcotics which induce complete stupor.
2. **Local.**—Cold, by means of the Ice bag (see Freezing mixtures, p. 809), and by the evaporation of Æther. Veratria, Aconitia.

These remedies produce loss of sensation, class 1 by an effect on the brain, and class 2 by a direct action on the sensory nerves of the skin or mucous membrane to which they are applied. These actions are fully considered in the body of the work.

NARCOTICS. Νάρκη, lethargy or stupor.

1. **Anodynes** (A, priv., ὀδύνη, pain).—Hot fomentations, Opium and its alkaloids, Cannabis Indica, Aconitia, Acidum hydrocyanicum dilutum, Conium, Atropia, Hyoscyamia, and Anæsthetics generrally.
2. **Hypnotics** (῾Υπνὸς, sleep).—Opium and its alkaloids, Chloral hydrate, Atropia, Hyoscyamia, Lactucarium, Laburnum, Inhalation of hop (as a hop-pillow), Carbonic anhydride and oxyde, Sulphuretted hydrogen.
3. **Mydriatics** (Μυδρίασις, dimness of sight, which in this class of remedies is due to dilatation of the pupil).—Atropia, Hyoscyamia, Stramonium, Cryptopia, Cannabis Indica.

Excepting some of the anodynes and hop, these medicines act on the nervous system generally, usually producing at first exaltation of the intellectual functions, and then progressive diminution, and in excessive doses complete stupor ending in coma, when they become anæsthesiants. But the coma produced by narcotics does not pass off speedily like that attending the use of anæsthesiants, and very often proves fatal.

SPASMODICS. Σπάσμα, convulsion or cramp.

1. **Excitors of the Voluntary Muscles.**—Strychnia, Brucia, Thebaia, Codeia, Electricity.
2. **Excitors of the Involuntary Muscle.**—Ergot, Digitalis, Atropia.

The members of the first class are otherwise called "Excito-motors," and those of the second class "Oxytocics" (*οξυς*, quick; *τοκετὸs*, child-bearing). The first term is equally applicable to both classes; the second only indicates a particular effect of ergot (see Action of Ergot and Digitalis, pp. 367 and 467).

ANTISPASMODICS. Αντι, against; σπάσμα, cramp.

1. **Paralysers of the Centres Motor.**—Conium, Physostigma, Curara, and the Anæsthesiants.
2. **Depressors of the Centres Motor.**—Those of the first class in

small doses, Bromide of potassium; Anæsthesiants in doses short of producing stupor; and Depressents.

These remedies are also called "Depresso-motors." Excepting the anæsthesiants, their action is confined to the motor centres, the intellect and common sensation remaining intact.

The medicines commonly called antispasmodics are included under Depressents and Carminatives.

DEPRESSENTS or SEDATIVES. *Sedo*, to calm.

1. **General Depressents.**—Tobacco, Lobelia, Digitalis, Colchicum, Squill, Veratrum, Hellebore, Aconite, Hydrocyanic acid, preparations of Antimony, Ipecacuanha.

These remedies are characterised by a general depression of the vital functions, in virtue of which they act as antispasmodics. They are indifferently classed with antispasmodics and emetics on account of their composite effects.

ANTISEPTICS. *Αντι, σηπτικὸς*, that causes to putrefy (fr. *σήπω*, to rot).

1. **General.**—Complete exclusion from the air by means of a layer of stearin or paraffin, and by hermetically sealing in a non-oxygenated medium; heat of 212° and above.
2. **Mineral.**—Arsenious acid, Corrosive sublimate, Chloride of zinc, Chlorine, Sulphates and Chlorides of copper and iron, Sulphurous and Hydrochloric acid gases, Chloride of sodium, Borax, Nitrates of potash and lead, Alum, caustic Lime.
3. **Vegetable.**—Alcohol, Æther, Chloral hydrate, Acidum carbolicum, Acidum salicylicum, Kreasotum, Sugar, the Essential oils, Tannic acid, Acetic acid, the fumes of burning Pitch.

These substances, also termed Antizymotics (*αντι, ξύμη*, fermenting matter) act by combining with the albumin and gelatin of the animal tissues, and the albumin, mucilage, cellulose, and even sugar of vegetable tissues, forming in each case insoluble, or only partially soluble compounds, which resist decay. They also destroy and prevent the development of the germs of vegetable life, which initiate and promote fermentative decomposition. Amongst mineral products, arsenious acid, corrosive sublimate, and chloride of zinc are the most powerful; and amongst the vegetable, kreasote and carbolic acid.

DISINFECTANTS.

1. **General.**—Heat at 212° and above. Air, Soil.
2. **Antiseptics.**—Many of these, especially the chlorides of the metals, are disinfectants.
3. **Special.**—Chlorine, Iodine, Bromine, Sulphurous acid, Charcoal, Lime water, solution of caustic Potash or Soda, Chlorinated lime and soda, caustic Lime, Permanganate of potash.

These remedies act, class 1 by driving off or decomposing the noxious matter; the remainder by removal of sulphuretted compounds, which are formed in the process of decomposition. Charcoal is very valuable in promoting the oxydation of animal exhalations. Solutions of lime and of the caustic alkalies remove excess ofcarbonic acid from the air.

Various circumstances influence the action of medicines, on account of which they cannot always be prescribed in the same doses, even to the same individual; but besides this, the mode of preparation, age, sex, mode of life, climate, and peculiar idiosyncracies, but especially age—all modify the doses in which medicines should be prescribed. The table formed by Gaubius is of some use as a general guide in respect of age.

GAUBIUS' TABLE

Regulating the Doses of Drugs according to the Age of the Patient.

For an adult, suppose the dose to be .			1	or	60	grains.
A person under	1 year	will require	$\frac{1}{12}$	,,	5	,,
,,	2 years	,,	$\frac{1}{8}$	,,	8	,,
,,	3 ,,	,,	$\frac{1}{6}$	,,	10	,,
,,	4 ,,	,,	$\frac{1}{4}$	,,	15	,,
,,	7 ,,	,,	$\frac{1}{3}$	,,	20	,,
,,	14 ,,	,,	$\frac{1}{2}$	,,	30	,,
,,	20 ,,	,,	$\frac{2}{3}$	,,	40	,,
,,	21 to 60 years, full dose, or		1	,,	60	,,

Above this age, an inverse gradation must be observed.

APPENDIX.

Aloin and Resin of Aloes.—Further observations on the action of these bodies corroborate the statements made in the text.

Spigelia Marylandica.—*Bot. Mag.* plate 80.

ANTIDOTES TO THE MORE ENERGETIC POISONS.

Acids, Mineral, Vegetable and Organic (such as carbolic acid).—Calcined magnesia, chalk, whiting, lime water, soap, the crushed plaster of the ceiling, oil.

Aconitia (see Atropia).

Ammonia and its Carbonate.—Vinegar and water, oil.

Antimony, Chloride of.—Magnesia, carbonate of soda.

Arsenious Acid.—Magnesia with milk, hydrated sesquioxyde of iron, powdered charcoal, a mixture of oil and lime water.

Atropia.—Ammonia, brandy, respiratory stimulation, diluents, and hydragogue purgatives.

Carbolic Acid.—Chalk, lime water, carbonate of soda, or Linimentum calcis, oil.

Chlorine.—Ammonia, magnesia.

Chloroform.—Artificial respiration, electricity, bleeding from a jugular vein.

Colchicum.—(See Tobacco).

Cyanide of Potassium and Hydrocyanic Acid.—A mixed solution of sulphate and perchloride of iron, cold affusion, ammonia respiratory stimulation.

Digitalis.—(See Tobacco).

Iodine.—Mucilago amyli, lime water.

Mercury, Corrosive Sublimate.—White of egg, flour and water, oil.

Oil of Bitter Almonds.—(See Hydrocyanic acid).

Opium.—Forced exercise, mustard and water, respiratory stimulation.

Oxalic Acid.—Chalk, magnesia, plaster of the ceiling, lime water.

Phosphorus.—Magnesia, oil.

Potash.—Vinegar and oil.

Salts of Sorrel.—(See Oxalic acid).

Silver, Nitrate of.—Common salt.

Strychnia.—Conium, opium.

Tobacco.—Subcutaneous injection of Atropia ($\frac{1}{50}$ grain), Ammonia, Brandy.

Zinc, Chloride of.—Carbonate of soda.

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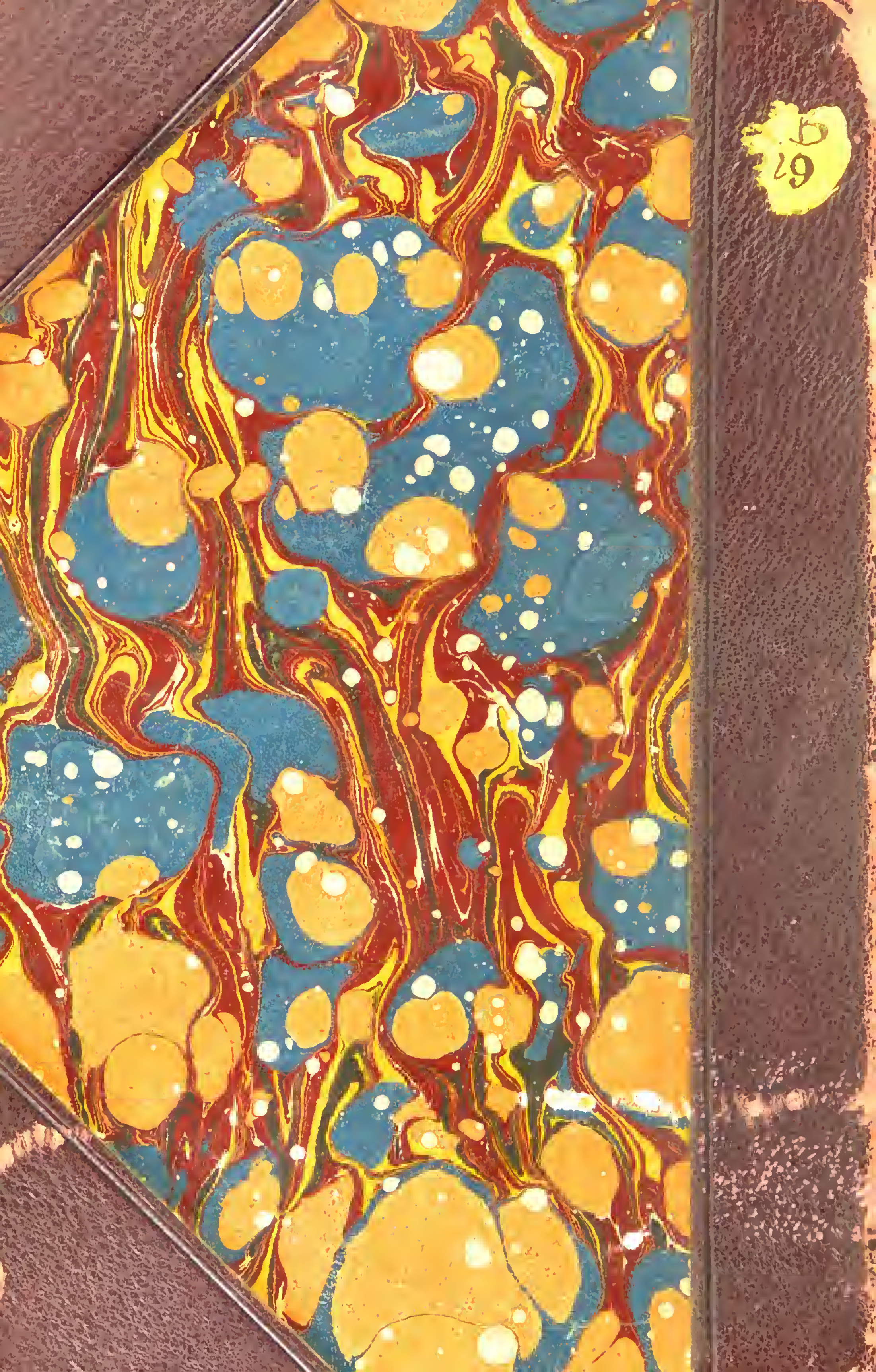

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